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DEVELOPMENT TEST II

OF

RADIO SET AN/GRC-103(V) WITH BAND IV COMPONENTS

FINAL REPORT

BY

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MAY 1977

U.S. ARMY ELECTRONIC PROVING GROUND
Fort Huachuca, Arizona 85613

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Radio Set AN/GRC-103(V)	Amplifier-Converter
Radio Terminal	Amplifier-Frequency Multiplier
Radio Relay	Terminal, Radio
	Relay, Radio

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The US Army Electronic Proving Ground conducted a DT II of Radio Set AN/GRC-103(V) with band IV components to determine to what extent it meets specification EL-CP0150-0001A; and to evaluate the safety, reliability, and maintainability of the test item in accordance with the approved plan of test.

Findings revealed that the test item was safe to maintain and it met the specification requirements except there was a 630 volt exposure to maintenance personnel without an accompanying warning label. The test item demonstrated

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Item 20 (cont)

serious reliability problems due to repeated failures of the frequency multiplier.

The test item endurance during environmental and physical test was satisfactory except for humidity and vibration tests. Problems encountered during maintenance evaluation include inadequate or missing manuals, part number inconsistencies, and component inaccessibilities.

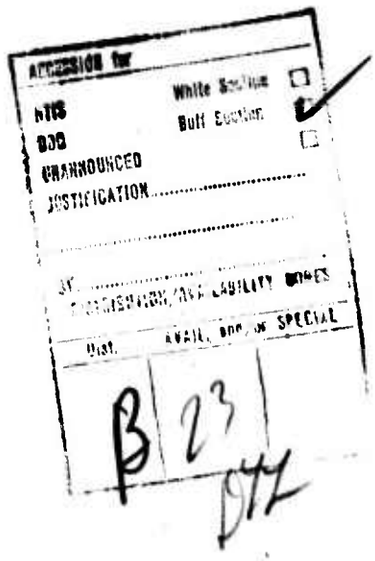
SUMMARY OF RESULTS

1. The technical performance of the AN/GRC-103(V) was generally good, however, the item demonstrated serious reliability problems (deficiency) due to repeated failure of the frequency multiplier.

2. Safety aspects were satisfactory with the exception of a 630 volt exposure to maintenance personnel without an accompanying warning label (shortcoming).

3. Test item endurance during environmental and physical tests was satisfactory except for humidity and vibration tests (deficiencies).

4. Problems encountered during maintenance evaluation include inadequate or missing manuals (deficiency) part number inconsistencies and component inaccessabilities (shortcomings).



FOREWORD

The US Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona, was responsible for test planning, execution, and reporting.

Numerous personnel within USAEPG provided valuable assistance to the author in the completion of this test program and the technical accuracy of this document. The ones who deserve special recognition are the enlisted personnel of the radio section, and Maintenance Evaluation, Lt. M. Arnwine of Environmental Test Facility, Raleigh Taylor of Technical Publications Branch, Bill Dunn and Ed Kawamura of Materiel Test Division, K. Hakes and D. Hunton of Electromagnetic Branch.

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SECTION 1. INTRODUCTION

1.1 BACKGROUND

Radio Set AN/GRC-103(V) was type classified standard A on 6 June 1968. An engineering and service test (ET and ST) of communications assemblages AN/TRC-113, AN/TRC-145, and AN/VRC-59, which include the AN/GRC-103(V) radio sets, was conducted by the US Army Electronic Proving Ground (USAEPG) in 1967. A subsequent check test of the AN/TRC-113 and AN/TRC-145 was conducted by USAEPG in 1969. A initial production test (IPT) of the AN/GRC-103(V) incorporating Band I components was conducted in 1972. The band IV components were designed to add an additional band of frequencies to the present AN/GRC-103(V) capabilities.

1.2 DESCRIPTION OF MATERIEL

a. The AN/GRC-103(V) is the basic radio set used with the Army Tactical Communications Systems (ATACS) Low Capacity Subsystems. The equipment consists of a complete, compact, rugged, radio relay whose major operating components may be used either as a terminal or modulation frequency patch repeater for intermediate or forward area systems. The radio set is used to provide simultaneous two-way (duplex) transmission, in the 76 to 1850 MHz frequency range using five bands of operation. When used in combination, either as a repeater or as a terminal, it is possible to tune and operate the receivers and transmitters on independent frequencies over the frequency range. (See fig. 1.)

b. The test items (Band IV Tuning Heads) extend the existing frequency range of the radio set, covering the RF spectrum from 1350 to 1850 MHz. The tuning heads, comprised of one Amplifier-Converter AM-4319 and one Amplifier-Frequency Multiplier AM-4323, will interchange with existing Band I, II, and III Tuning Heads.

c. The Band IV radio set, due to the higher frequency range covered, requires a different type antenna. Whereas the basic models used a corner reflector, the Band IV utilizes a small dish (parabolic) type reflector. Nomenclature of the Band IV small dish reflector antenna is AS-3047( )/GRC-103. Performance testing of this new type antenna was accomplished during the test period.

1.3 TEST OBJECTIVE

The objective of this test was to evaluate the AN/GRC-103(V) Band IV in accordance with Electronics Command Development Specification EL-CP0150-0001A, dated 11 December 1972.

1.4 SCOPE

a. Testing was conducted at Fort Huachuca, Arizona, during the period November 1975 through December 1976.

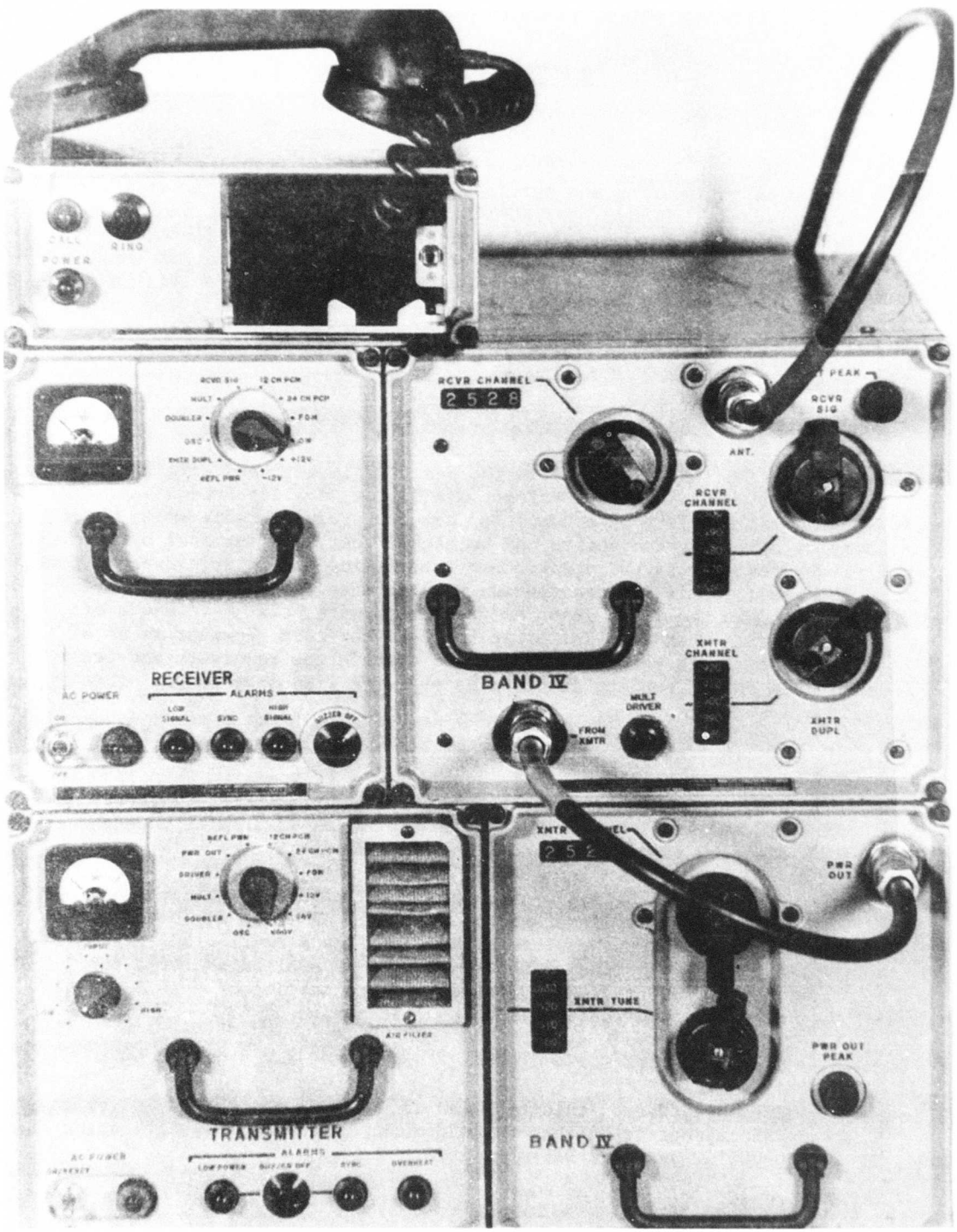


Figure 1. Radio Set AN/GRC-103(V).

b. Ten radio sets AN/GRC-103(V) Band IV were received for testing. Three of these were installed in a modified radio repeater assemblage AN/TRC-110 and two were installed in modified radio terminal assemblage AN/TRC-117. A system test, utilizing these two configurations was conducted during the test period. The remaining five sets were subjected to the requirements of Specification (EL-CP0150-0001A). However, approved contractor test data were utilized for subtest 2.18 in evaluating test item performance.

c. The standard test conditions defined below were maintained:

(1) Primary power. Selected electrical measurements taken covering the input line voltage power range of the test item were made at the following voltage/frequency combinations:

Line Voltage (Vac)	Line Frequency (Hz)
115.0	60.0
103.5	60.0
126.5	60.0
115.0	47.5
103.5	47.5
126.5	47.5
115.0	420.0
103.5	420.0
126.5	420.0

(2) Test frequencies. Electrical measurements were made with the transmitter or receiver tuned to the test frequencies shown below, or as stated in a specific subtest. The frequencies shown with an asterisk (*) were used to spot-check measurements when referenced in a subtest procedure.

Test Frequencies

Channel	Frequency	Channel	Frequency	Channel	Frequency
2300*	1350.0	2818	1609.0	3100	1750.0
2391	1395.5	2891	1645.5	3110*	1755.0
2500	1450.0	2900	1650.0	3197	1798.5
2671	1535.5	2961	1680.5	3257	1828.5
2672*	1536.0	2964*	1682.0	3276	1838.0
2700	1550.0	3037	1718.5	3299	1849.5

d. The following information was recorded on the data forms during all subtests: Test item serial numbers, test equipment used and serial numbers, test date, name of person collecting the data, and location of test. Photographs of the test items were taken upon receipt of the equipment.

e. Prior to initiation of testing, all equipments were thoroughly checked by maintenance personnel to assure that they were operational.

f. Testing of the Order Wire Unit RT-773/GRC-103(V) was not done. This unit was thoroughly tested during previous tests, and did not require additional testing. The unit was used extensively during the test period, and any malfunction was recorded and reported.

g. Per directive from the US Army Test and Evaluation Command (TECOM), a maintenance evaluation addressing specifically those components which comprise Band IV (tuning head and antenna) was required.

h. Test procedures outlined in Materiel Test Procedures (MTP) 6-2-020 and 6-2-288 were used in preparing the methods described in the subtests of this report.

i. An AN/GRC-103(V) Test Facility (TS2867(V)1/GRM/95) was required for performing maintenance on the radio set. This is a depot test equipment item and was not available at this installation during the test period.

j. The operational hours accrued during the testing time frame provided an adequate statistical base for the results.

k. Soldier-operator/maintainer/tester comments were solicited.

l. The test item has no adverse impact on the environment.

SECTION 2. DETAILS OF TEST

2.1 PRETEST INVENTORY AND INSPECTION

2.1.1 Objective

The objective was to determine the receipt condition and completeness of the test item and maintenance test package, and to insure prior to testing that the test item was in operating condition.

2.1.2 Criterion (Approved Test Plan)

The test item and maintenance test package shall be complete and in operating condition prior to start of testing.

2.1.3 Data Acquisition Procedure

The test officer in conjunction with maintenance evaluation personnel and the safety officer performed the initial inventory and pretest operational inspection to include --

a. An unpacking and inventory of the test item and maintenance test package using the appropriate instructions of the applicable equipment publications. A comparison of the contents with the packing list, maintenance test package list, and/or other applicable documents to determine if any discrepancies exist.

b. An inspection of the test item and maintenance test package for any missing or inappropriate special markings which caution the handlers.

c. An inspection of the test item and maintenance test package for evidence of physical damage.

d. Conducting pretest performance checks and adjustments by setting up and operating the test item following the instructions in the applicable equipment publications.

2.1.4 Results

a. There was no physical damage noted to the test item and maintenance test package.

b. There was no record of missing or inappropriate special markings.

c. Amplifier - Frequency Multiplier AM-4323, SN 0008, was found to have no driver or power output. Replacement of tubes V1 and V2, and voltage regulator 40A3 did not correct the failure. A replacement (SN 0006) was received.

d. The following discrepancies of the maintenance test package were noted.

(1) The Maintenance Allocation Chart (MAC) was missing from the Draft Technical Manual DTM 11-5820-540-12. The MAC was received as an addition prior to the start of test.

(2) A cable kit FSN 5820-00-935-5026 was missing on SN 0008

(3) A 9 inch/pound, open end 5/16 inch torque wrench was missing.

e. The DS/GS repair parts manual was not received.

2.1.5 Analysis

a. The absence of the MAC, special purpose cable, and torque wrench required to perform maintenance operations delayed the start of test.

b. The lack of receipt of the DS/GS parts manuals precluded the evaluation of repair parts at the appropriate levels of maintenance.

2.2 SAFETY

2.2.1 Objective

The objective of this subtest was to determine if the test item is safe to operate and maintain.

2.2.2 Criteria

The test item shall meet the pertinent safety requirements of the following:

a. MIL-STD-454C.

b. MIL-STD-1472A

2.2.3 Data Acquisition Procedure

a. A safety officer and the test officer conducted a safety survey of the test item.

b. A continuous safety surveillance was maintained by project personnel throughout testing to detect and define material, design handling, or other factors that might be safety hazards to personnel or equipment.

c. Coordination was effected between the safety officer and test officer to insure that a sufficient amount of soldier-operator/maintainer exposure in the area of safety was sustained to provide a comprehensive evaluation of the degree of the conformance with criteria.

d. Test personnel recorded unsafe conditions noted during the test.

e. A safety release recommendation was submitted in accordance with TECOM Supplement 1 to AMCR 385-12.

f. MIL-STD-882 was used as a guide to classify hazard levels, which in turn became the basis for shortcoming and deficiency determination.

2.2.4 Results

During the conduct of the test, only one unsafe condition was noted. There was no voltage warning label affixed adjacent to plug 40A1W1A1P1 of the amplifier-Frequency Multiplier AM-4323/GRC-103. A voltage of 630 Vdc was exposed on FL1 filter when the Band IV cover was removed. One of the maintenance personnel received a shock from this exposed voltage.

2.2.5 Analysis

The absence of a voltage warning label does not constitute a hazard to operating personnel but does constitute a marginal hazard to maintenance personnel since they may be exposed to the 630 Vdc during the performance of internal maintenance operations. (Shortcoming)

2.3 PHYSICAL CHARACTERISTICS

2.3.1 Objective

The objective of this subtest was to determine if the radio set meets specified physical characteristics.

2.3.2 Criteria (EL-CP0150-0001A, para 3.18)

a. The equipment cases housing the individual radio set components shall not exceed the following dimensions:

(1) Transmitter (with integral power supply and any one tuning unit) depth - 12 inches (29.2 cm); width - 17-3/8 inches (44.12 cm); height - 8-1/2 inches (21.5 cm).

(2) Receiver (with integral power supply and any one tuning unit) depth - 12 inches (29.2 cm); width - 17-3/4 inches (45.08 cm); height - 8-1/2 inches (21.5 cm).

b. The weight of the radio set components when installed in their cases shall not exceed the following:

(1) Transmitter (with integral power supply and any one tuning unit) - 65 pounds (29.48 Kg).

(2) Receiver (with integral power supply and any one tuning unit) - 65 pounds (29.48 Kg).

(3) Receiver-Transmitter, Order Wire RT-773( )/GRC-103(V) - 7.6 pounds (3.44 Kg).

2.3.3 Data Acquisition Procedure

a. The depth, width, and height of the receiver and transmitter (SN 005, 006, 008 and 009) were measured.

b. The transmitter, receiver, and order wire units and their cases were weighed.

c. Linear measurements were recorded in inches to an accuracy of 1/16-inch. Weight measurements were made in pounds/ounces to an accuracy of 1/10 pounds.

2.3.4 Results

a. The receiver's dimensions are 12.0 inches (29.2 cm) in depth, 17-1/4 inches (43.81 cm) in width, and 8-1/2 inches (21.5 cm) in height while the transmitter's dimensions are 12-1/8 inches (30.9 cm) in depth, 17.5 inches (44.4 cm) in width, and 8.5 inches (21.5 cm) in height.

b. The receiver weight is 57 lbs 9 oz (26.0 Kg), the transmitter weight is 57 lbs (25.85 Kg), and the order wire unit weight is 7 lbs 8 oz (3.4 Kg).

2.3.5 Analysis

The size and weight of the test item fell within the specified limits. The 1/8-inch difference in the height of the transmitter is insignificant. The test item is considered to have met the criteria.

2.4 VISUAL AND MECHANICAL

2.4.1 Objective

The objective of this subtest was to determine, by visual inspection, if the test item has mechanical defects.

2.4.2 Criteria (MIL-R-55656(EL)

The test item shall not have any of the defects listed in MIL-STD-252B.

2.4.3 Data Acquisition Procedure

The equipment was visually examined for the defects listed in MIL-STD-252B, and again during required maintenance. In addition, one radio set was disassembled at the conclusion of the DT II and thoroughly examined for MIL-STD-252B defects.

2.4.4 Results

No defects were found.

2.4.5 Analysis

The test item (SN 009) had no defects listed in MIL-STD-252B.

2.5 POWER REQUIREMENTS

2.5.1 Objective

The objective of this subtest was to determine if the radio set can be operated from specified power sources.

2.5.2 Criteria (EL-CP0150-0001A, para 3.16)

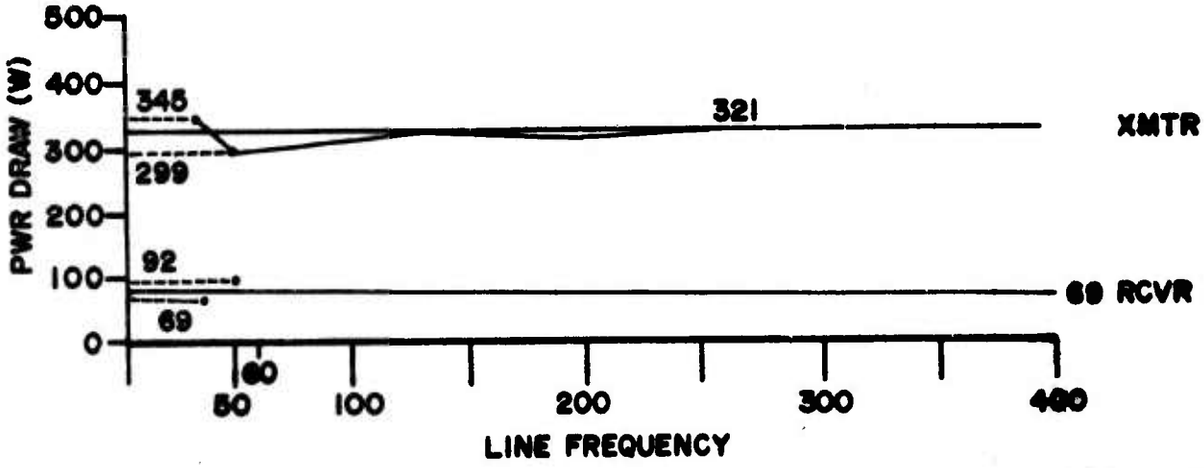
The equipment shall operate from a 115 Vac, 47.5 to 420 Hz, single phase source, having a voltage variation of ±10 percent. The total power drain for a transmitter and receiver shall not exceed 400 watts at normal operating conditions.

2.5.3 Data Acquisition Procedure

a. The receiver, transmitter (SN 005), and order wire unit were interconnected, with the antenna terminated in a dummy load, the receiver frequency tuned 16 MHz from the transmitter frequency, and the transmitter RF power output peaked. See figure 2.

b. The power delivered to the radio set from 115 Vac at 50, 60, and 400 Hz sources was measured, with the transmitter tuned to channel 2810 and the receiver tuned to channel 2740.

2.5.4 Results



2.5.5 Analysis

The test item is capable of operating from various 50, 60, and 400 Hz power sources without degradation of performance. The test item is considered to have met the criteria.

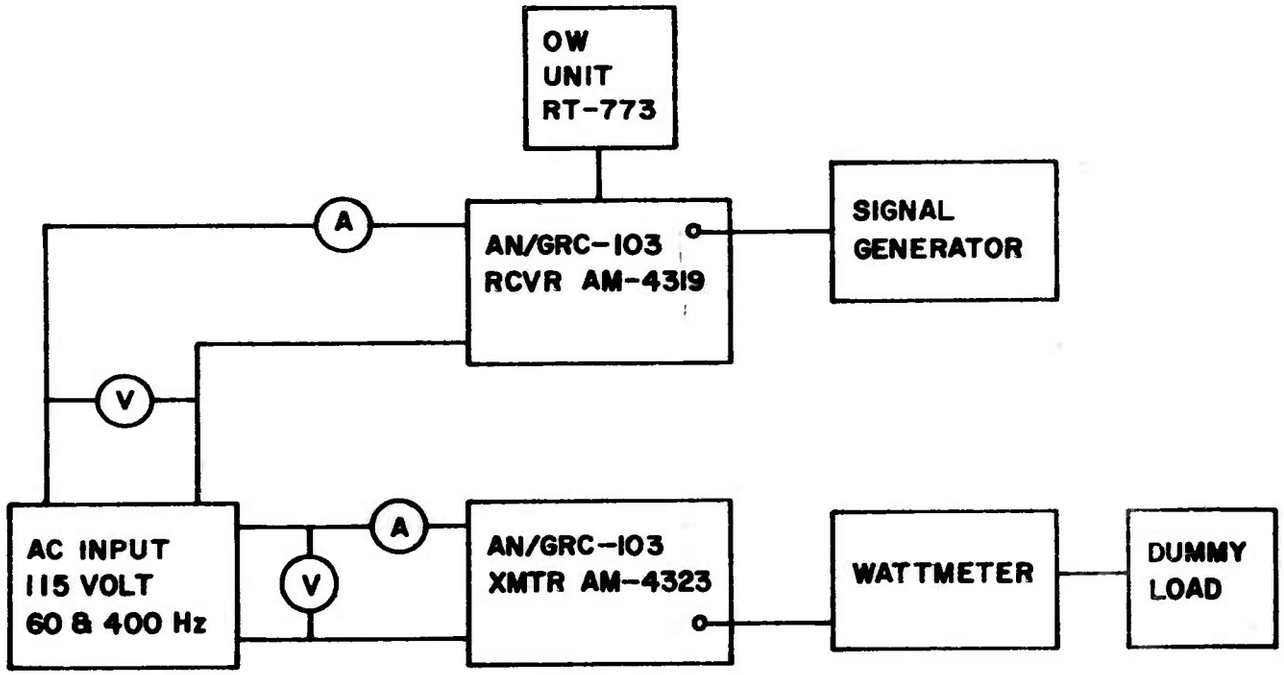


Figure 2. Test setup for power requirements.

2.6 INTERCHANGEABILITY

2.6.1 Objective

The objective of this subtest was to determine if like components and parts of the equipment can be interchanged without degrading the performance of the equipment.

2.6.2 Criteria (EL-CP0150-0001A, para 3.12)

Like units, assemblies, subassemblies and replaceable parts shall be physically and functionally interchangeable, not requiring modification or adjustment except operator adjustments.

2.6.3 Data Acquisition Procedure

Electrical and mechanical interchangeability were demonstrated by disassembling all normally removable modules from two radio sets, interchanging approximately half the modules and reassembling. The main frame assemblies were interchanged between cases. Subtests 2.5 and 2.13 were performed on both radio sets.

2.6.4 Results

Upon reassembly, units 009 and 010 performed properly.

2.6.5 Analysis

Like units, assemblies, subassemblies, and replaceable parts are physically and functionally interchangeable.

2.7 TRANSMITTER POWER OUTPUT

2.7.1 Objective

The objective of this subtest was to determine if the transmitter can deliver the required RF power output.

2.7.2 Criteria (EL-CP0150-0001A, para 3.13.4.1)

The normal transmitter power output measured before the RF duplexer shall be at least 15 watts, under operating conditions of room ambient, high and low temperature, humidity or altitude. The transmitter output power shall be at least 10 watts at 103.5 volts ac line voltage and at least 15 watts for any line voltage in excess of 115 volts.

2.7.3 Data Acquisition Procedure

a. The test setup configuration is shown in figure 3.

b. The transmitter (SN 006) was tuned to a test frequency, the output power peaked, and the peak reading recorded.

c. The method in paragraph b above was performed at the test frequencies and primary line voltage and frequencies listed in the standard test conditions, paragraph 1.4c.

2.7.4 Results

a. The ambient temperature was 75°F.

b. See table I.

c. Power output tests conducted under environmental extremes are addressed under the appropriate environmental subtests.

2.7.5 Analysis

The test item operated without sustaining damage or deterioration in power output when subjected to high and low temperature, room ambient, and humidity or altitude. The not meeting of the criteria on channel 2964 is not considered to be characteristic of the radio, therefore the test item is considered to have met the criteria.

TABLE I. TRANSMITTER POWER OUTPUT TEST RESULTS

Voltage	Power Frequency (Hz)	Power Output (W)	Channel No.
115	60	18	2300
		25	2672
		13	2964
		28	3110
103.5	60	22	3110
		12	2964
		21	2672
		15	2300
126.5	60	19	2300
		27	2672
		12	2964
		29	3110
115	47.5	22	3110
		11	2964
		23	2672
		16	2300
103.5	47.5	14	2300
		22	2672
		12	2964
		22	3110
126.5	47.5	28	3110
		12	2964
		28	2672
		18	2300
115	420	15	2300
		23	2672
		11	2964
		23	3110
103.5	420	20	3110
		10	2964
		20	2672
		14	2300
126.5	420	19	2300
		25	2672
		12	2964
		17	3110

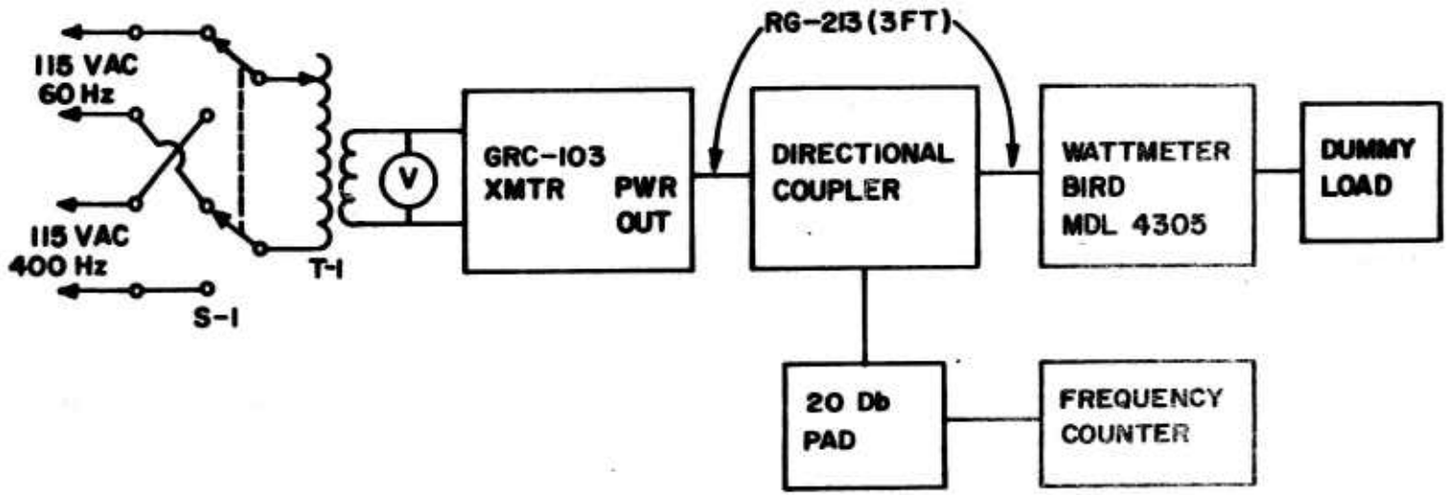


Figure 3. Test setup for transmitter power output, frequency settability, and RF transmitter alarm.

2.8 TRANSMITTER POWER DISSIPATION

2.8.1 Objective

The objective of this subtest was to determine if the transmitter will limit the high-level power tube plate dissipation to the recommended maximum values under adverse conditions.

2.8.2 Criteria (EL-CP0150-0001A, para 3.13.4.2)

The transmitter shall have provision for maintaining the high level power tubes within their recommended plate dissipation ratings under conditions of no excitation, or when the RF terminals are open circuited or shorted.

2.8.3 Data Acquisition Procedure

a. The test setup is shown in figure 4.

b. The transmitter (SN 008) was tuned to 1350 MHz and the RF power output delivered to the dummy load was noted and recorded.

c. The RF (PWR OUT) terminal was then short circuited and the transmitter operated for 15 minutes.

d. The short circuit was then removed, the wattmeter and dummy load replaced and the power output again noted and recorded.

e. The RF (PWR OUT) terminal was then open circuited, the transmitter operated for another 15 minutes, the wattmeter and dummy load again connected and the power output noted and recorded.

f. The XMTR CHANNEL selector was then advanced 50 channels, leaving the tuning controls in their original position, and the transmitter operated for 30 minutes.

g. The XMTR CHANNEL selector was then reset to 1350 MHz, and after a 5-minute operation the RF power output again measured.

2.8.4 Results

a. The power out under normal conditions was 18 watts.

b. The power out under short circuit conditions was 16 watts.

c. The power out under open circuit conditions was 16 watts.

d. The power out under loss of excitation conditions was 16 watts.

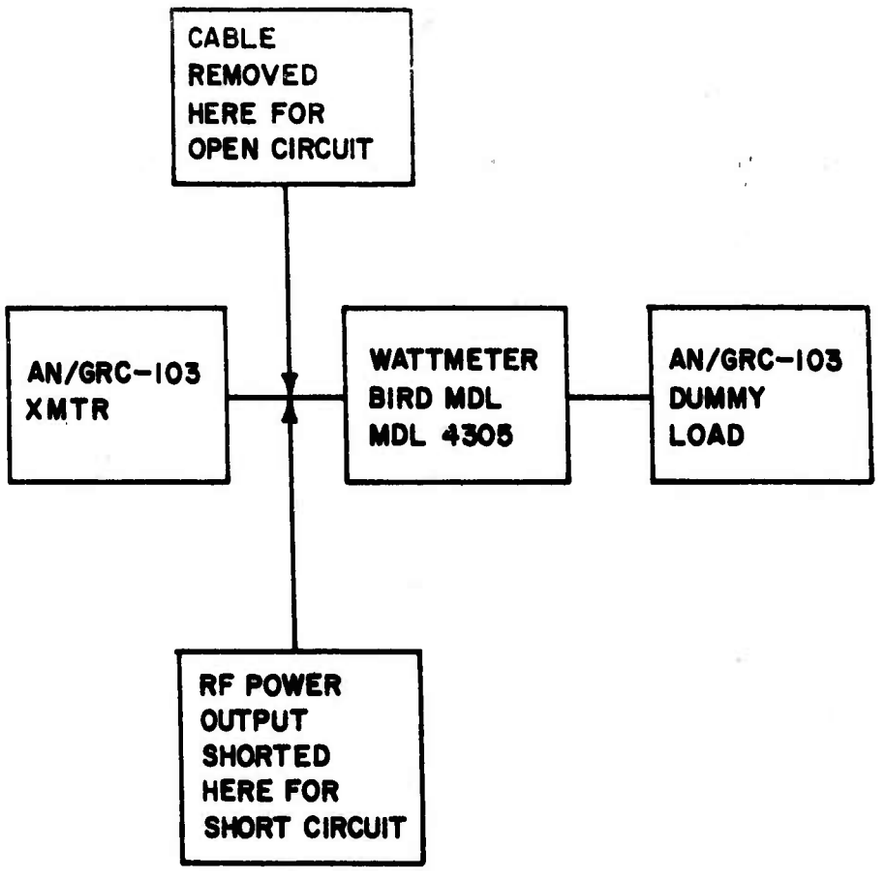


Figure 4. Test setup for transmitter power dissipation.

2.8.5 Analysis

The transmitter has provision for maintaining the high level power tubes within their recommended plate dissipation. The criteria was met.

2.9 TRANSMITTER FREQUENCY STABILITY

2.9.1 Objective

The objective of this subtest was to determine the transmitter frequency stability.

2.9.2 Criteria (EL-CP0150-0001A, para 3.13.4.3)

The transmitter when set to any channel in any band, after 15-minute warmup and at any ambient temperature between -35° and +125°F (-37.2° and +51.6°C) shall not vary beyond ±0.002 percent of the nominal channel frequency for the next 8 hours. The ambient temperature may vary up to 54°F (12°C) within the prescribed limits during the 8-hour period.

2.9.3 Data Acquisition Procedure

a. Test setup is shown in figure 5.

b. The transmitter (SN 0009) was tuned to a convenient frequency and coupled through a HP 774D directional coupler into the dummy load and through 50 dB of attenuation to a HP 5245 M/L counter and HP 5253A prescaler.

c. Frequency measurements were taken after a 15-minute transmitter warmup. The sampling interval was 30 seconds for the first 30 minutes, and 3 minutes for the remainder of the 8 hour period.

d. The test chamber ambient temperature was cycled between +20° and +74°F during the 8 hour test period.

2.9.4 Results

a. Nominal frequency formula:

$$\text{channel frequency} = \frac{\text{channel number on dials}}{2} + 200$$

i.e., channel number = 2300

$$\text{channel frequency} = \frac{2300}{2} + 200$$

$$= 1350 \text{ MHz}$$

b. The data is voluminous and can be provided upon request however, at no time during the test did the actual frequency vary from the nominal frequency by more than a -.0008 percent (-.01 MHz).

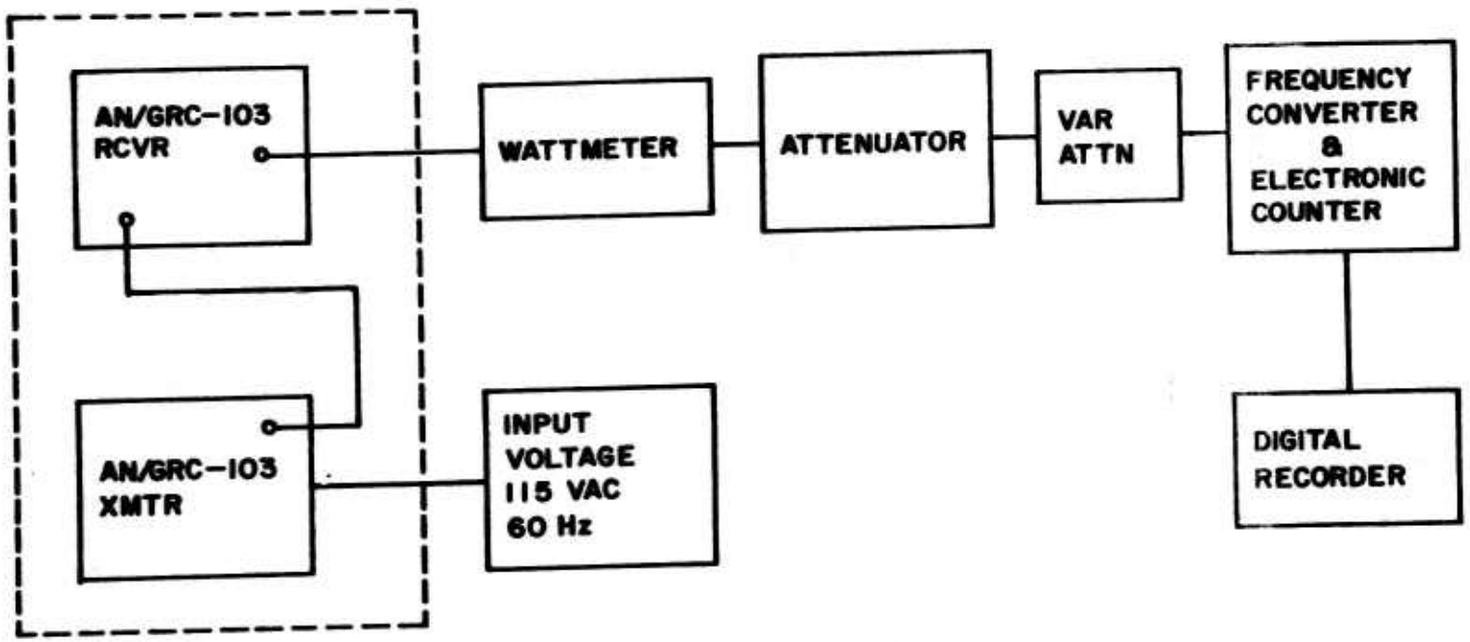


Figure 5. Test setup for transmitter frequency stability.

2.9.5 Analysis

The transmitter when set to any channel in any band, after 15-minute warmup and at any ambient temperature between -35 and +125°F did not vary from the nominal frequency by more than -.0008 percent (-.01 MHz). The test item met the criteria.

2.10 TRANSMITTER FREQUENCY SETTABILITY

2.10.1 Objective

The objective of this subtest was to determine the transmitter frequency settability.

2.10.2 Criteria (EL-CP0150-0001A, para 3.13.4.4)

It shall be possible to align the transmitter to within .002 percent of the desired frequency by the use of an integral indicator, calibrated in RF channel numbers.

2.10.3 Data Acquisition Procedure

a. The transmitter (SN 005) was coupled through a HP 774D directional coupler into the dummy load and through 50 dB of attenuation to a HP 5245 M/L counter with a HP 5254 prescaler. See figure 3.

b. The transmitter channel selector switch and tune control was set to a test frequency and, after a 15-minute warmup, the transmitter frequency was measured.

c. The method above was performed at the standard test condition frequencies listed in paragraph 1.4c.

2.10.4 Results

At no time during the test were the actual frequencies more than .01 MHz below the test frequency.

Channel	Nominal Frequency	Actual Frequency
2300	1350	1349.99
2672	1536	1535.99
2964	1682	1681.99
3110	1755	1754.99

2.10.5 Analysis

It is possible to align the test item to within .002 percent of the desired frequency. The test item met the criteria.

Nominal Frequency (MHz)	Difference from Actual Frequency (MHz)	Percent Deviation
1350	.01	.00074
1536	.01	.00065
1682	.01	.00059
1755	.01	.00057

2.11 RF TRANSMITTER ALARM

2.11.1 Objective

The objective of this subtest was to determine if the transmitter low power lamp, buzzer, and buzzer off button operate properly.

2.11.2 Criteria (EL-CP0150-0001A, para 3.13.4.6)

The visual alarm shall indicate any change in RF power output that is greater than 8 ±1dB below the nominal power output rating of the transmitter. A push-to-operate switch shall be included such that in one switch position the alarm shall sound when the visual alarms are lighted as in the case of a failure, and in the second switch position the alarm sounds when the light is not lighted.

2.11.3 Data Acquisition Procedure

a. The transmitter (SN 006) was connected to a Bird Model 43 wattmeter and the dummy load, tuned to a test frequency, and the RF power output peaked. See figure 3.

b. The BUZZER OFF button was operated to see if the buzzer would change state upon each depression of the button. The button was depressed at least twice and its operation noted. The final state of the buzzer was OFF.

c. The transmitter RF power output was reduced to an alarm condition, using the PWR OUT PEAK control, the state of the low power lamp and buzzer was noted, and method b above performed.

d. The transmitter RF output power was returned to normal operation using the PWR OUT PEAK control, the state of the low power lamp and buzzer noted, and method b above performed.

e. The above methods were performed at the test frequencies indicated by an asterisk (*) in the standard test conditions, paragraph 1.4c.

2.11.4 Results

The low power lamp, the buzzer, and the buzzer off button operated as required.

Frequency	Peak Power Out (dBm)	Alarm Power Out (dBm)	Change in Power Out (dB)
1350	32.01	34.77	8.24
1536	42.79	34.77	8.02
1682	43.01	34.77	8.24
1755	42.55	34.77	7.78

2.11.5 Analysis

The visual alarm indicated changes in RF power output greater than 8 ±1 dB, and the push-to-operate switch operated correctly. The criteria was met.

2.12 TRANSMITTER FREQUENCY RESPONSE

2.12.1 Objective

The objective of this subtest was to determine if the transmitter has the specified frequency response.

2.12.2 Criteria (EL-CP0150-0001A, para 3.13.4.7)

The overall frequency response of the transmitter shall conform to the following:

Modulating Frequency (kHz)	Relative Attenuation (dB)		
	Nominal	Minimum	Maximum
0.125	1.0	0.5	1.5
0.200	0.5	0.0	1.0
0.250	0.2	0.0	0.4
1.000	0.0	0.2	0.2
10.000	REFERENCE	---	---
30.000	0.0	-0.2	0.2
60.000	0.1	0.0	0.3
120.000	0.15	0.0	0.5
240.000	0.7	0.5	1.3
360.000	1.3	0.6	2.3
480.000	2.7	1.9	4.4
600.000	4.2	3.4	6.9
720.000	6.0	5.3	9.8
840.000	8.2	7.5	13.0
960.000	10.7	8.5	15.0

2.12.3 Data Acquisition Procedure

a. The test setup shown in figure 6 was used. The transmitter (SN 008) was tuned to the test frequency and the voltage controlled oscillator tuned to 30 MHz above the test frequency.

b. The test oscillator output level was adjusted to give ±100 kHz peak deviation (25 percent FSD meter indication at 10 kHz).

c. With the coaxial switch in position 1 the level meter reading was recorded.

d. The coaxial switch was set to position 2, the variable attenuator was adjusted to obtain the same meter reading recorded in step c, and the attenuation recorded.

e. The input signal was tuned to each of the frequencies listed in the criteria and methods b through d repeated.

f. The method above was performed at the test frequencies shown by an asterisk (*) in the standard test conditions, paragraph 1.4c.

2.12.4 Results

The data collected was within the maximum and minimum relative attenuation for all test modulating frequencies. The data is voluminous and can be provided upon request, however, the data collected was within the maximum and minimum relative attenuation for all test modulating frequencies.

2.12.5 Analysis

The overall frequency response of the transmitter met the criteria shown in paragraph 2.12.2.

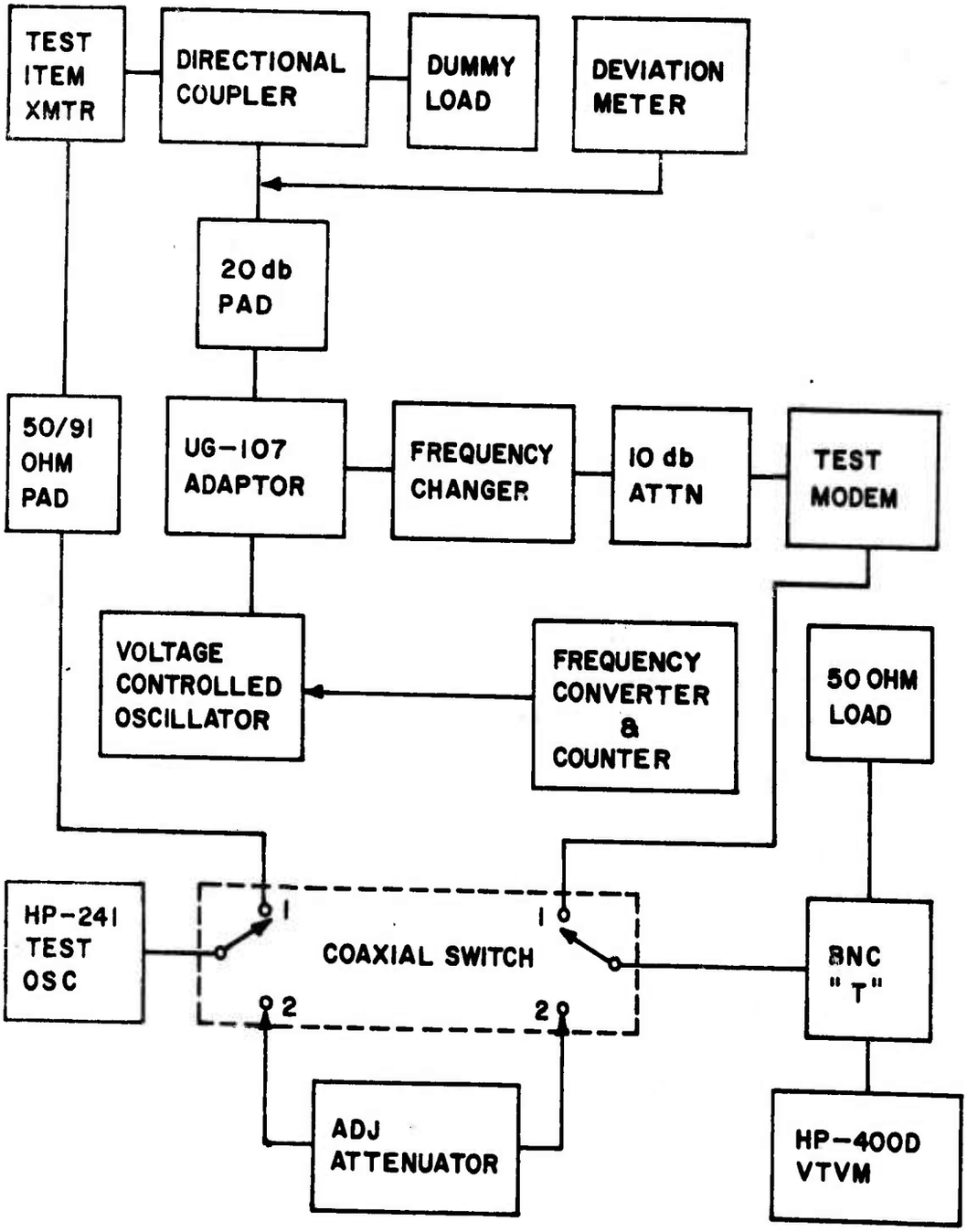


Figure 6. Test setup for transmitter frequency response.

2.13 TRANSMITTER DUMMY ANTENNA

2.13.1 Objective

The objective of this subtest was to determine the dummy antenna VSWR, non-reactive impedance, and power dissipation capabilities.

2.13.2 Criteria (EL-CP0150-0001A, para 3.13.4.8)

The dummy antenna shall be capable of dissipating the maximum RF power delivered by the transmitter, presenting a non-reactive 50-ohm load over the entire frequency range. The VSWR shall not exceed 1.5.

2.13.3 Data Acquisition Procedure

a. The test setup shown in figure 4 was used.

b. The transmitter (SN 009) was tuned to a test frequency, its output power maximized, and the forward and reflected power (as indicated on the RF THRU-LINE wattmeter) recorded.

c. The transmitter was allowed to operate at this test frequency for a period of 1 hour, after which time the forward and reflected power was measured again.

d. This procedure was performed at test channels 2300, 2573, 2755, 2937 and 3299, and with four different dummy antennas (DA-437).

2.13.4 Results

The reflect power in all tested cases was 0.

2.13.5 Analysis

The dummy antenna was capable of dissipating the maximum RF power delivered by the transmitter. The VSWR was 1.0 thereby presenting a nonreactive 50-ohm load over the entire frequency range. The test item met the criteria.

2.14 TRANSMITTER INPUT IMPEDANCE

2.14.2 Objective

The objective of this subtest was to determine the transmitter input impedance.

2.14.2 Criteria (EL-CP0150-0001A, para 3.13.11)

The impedance at the video input to the transmitter shall be 91 ohms ±5 percent resistive to at least 480 kHz and 91 ohms ±15 percent to at least 800 kHz.

2.14.3 Data Acquisition Procedure

a. The test setup is shown in figure 7.

b. The transmitter video input level control was set at mid-range.

c. Vector impedance meters HP-4800A or HP-4815A were connected to the video input connector on the transmitter.

d. The transmitter (SN 005) was energized and tuned to a test frequency.

e. Vector impedance measurements were made at input frequencies of 1, 50, 100, 250, 400, 480, 650, and 800 kHz.

2.14.4 Results

The results are shown below:

Input Impedance (ohms)	93	95	94	93	93	93	92	92
Input Frequency (kHz)	1	50	100	250	400	480	650	800

2.14.5 Analysis

The impedance at the video input to the transmitter was within the specified limits. The criteria were met.

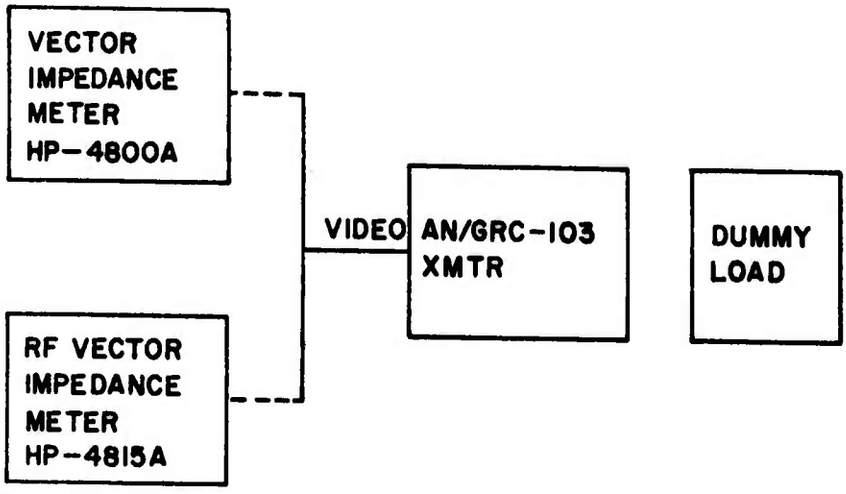


Figure 7. Test setup for transmitter input impedance.

2.15 RECEIVER NOISE FIGURE

2.15.1 Objective

The objective of this subtest was to determine the receiver noise figure.

2.15.2 Criteria (EL-CP0150-0001A, para 3.13.5.1)

The noise figure of the receiver shall not exceed 8 dB. This value shall include the losses due to the receiver protection device and the duplexer.

2.15.3 Data Acquisition Procedure

a. The test setup is shown in figure 8.

b. The receiver (SN 006) and RF signal generator were tuned to the test frequency.

c. The transmitter section of the receiver duplexer was tuned to 100 channels below the test frequency.

d. The receiver tuning was adjusted for maximum receiver quieting, as indicated on the VTVM, and the signal generator tuning was rechecked for maximum quieting.

e. The VTVM quieting at that test frequency was recorded. The receiver noise figure was then computed by subtracting the VTVM reading from -54.6 dBm (which is the maximum receiver quieting).

f. Other noise figure measurements at specified frequencies were performed.

2.15.4 Results

The results are shown below:

Channel	Frequency (MHz)	VTVM (-dBm)	Noise Figure (dB)
2300	1350.0	47.2	7.4
2672	1536.0	48.5	6.1
2964	1682.0	47.9	6.7
3110	1755.0	48.4	6.2
3299	1849.5	47.8	6.8

2.15.5 Analysis

The noise figure of the receiver did not exceed 8 dB. The criteria was met.

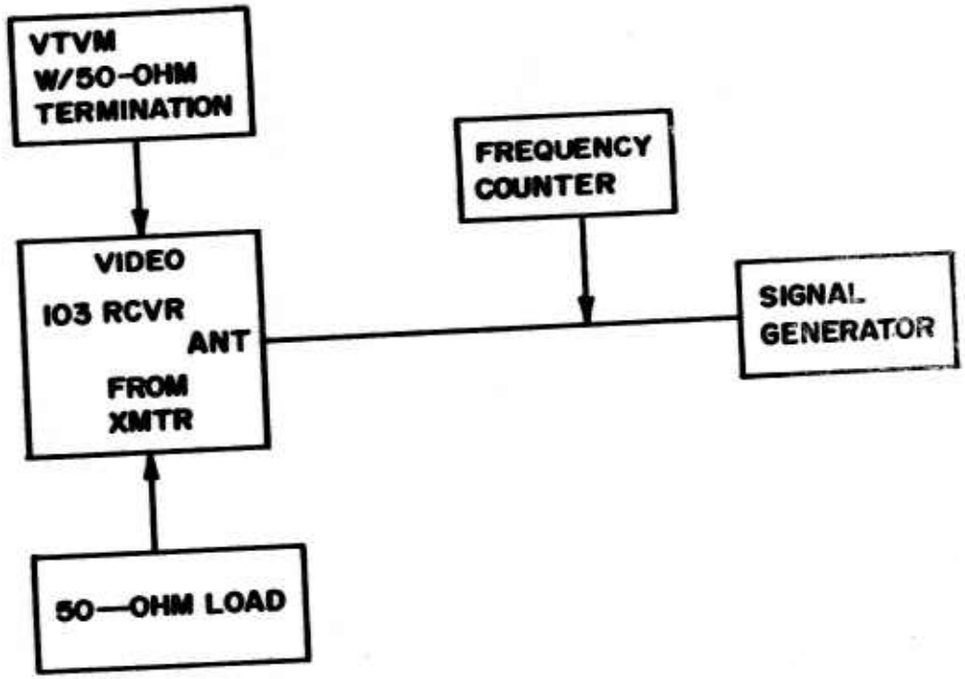


Figure 8. Test setup for receiver noise figure.

2.16 RECEIVER FREQUENCY SETTABILITY

2.16.1 Objective

The objective of this subtest was to determine the receiver frequency settability.

2.16.2 Criterion (EL-CP0150-0001A, para 3.13.5.4)

It shall be possible to align the receiver to within 0.002 percent, ±20 kHz of the desired frequency by use of an integral indicator, calibrated in RF channel numbers.

2.16.3 Data Acquisition Procedure

a. The test setup is shown in figure 9.

b. The receiver (SN 008) was tuned to a test frequency and the power output of the frequency multiplier stage (2A1A2A1) maximized.

c. The frequency multiplier output was switched to the frequency counter and the frequency recorded. NOTE: The frequency multiplier stage provided the final local oscillator frequency, whose output when tuned properly is 30 MHz above the channel frequency.

d. The above procedure was performed at channels 2300, 2573, 2755, 2937, and 3299 and with input line voltages of 105, 115, and 125 Vac, 60 Hz.

2.16.4 Results

The frequency error for all tested channels was -10 kHz.

Channel No.	Calculated Frequency	Voltage	Frequency Multiplier Frequency
2300	1350.00	105	1379.99
2573	1486.50	105	1516.49
2755	1577.50	105	1607.49
2937	1668.50	105	1698.49
3299	1849.50	105	1879.49
2300	1350.00	115	1379.99
2573	1486.50	115	1516.49
2755	1577.50	115	1607.49
2937	1668.50	115	1698.49
3299	1849.50	115	1879.49
2300	1350.00	125	1380.00
2573	1486.50	125	1516.50
2755	1577.50	125	1607.50
2937	1668.50	125	1698.50
3299	1849.50	125	1879.50

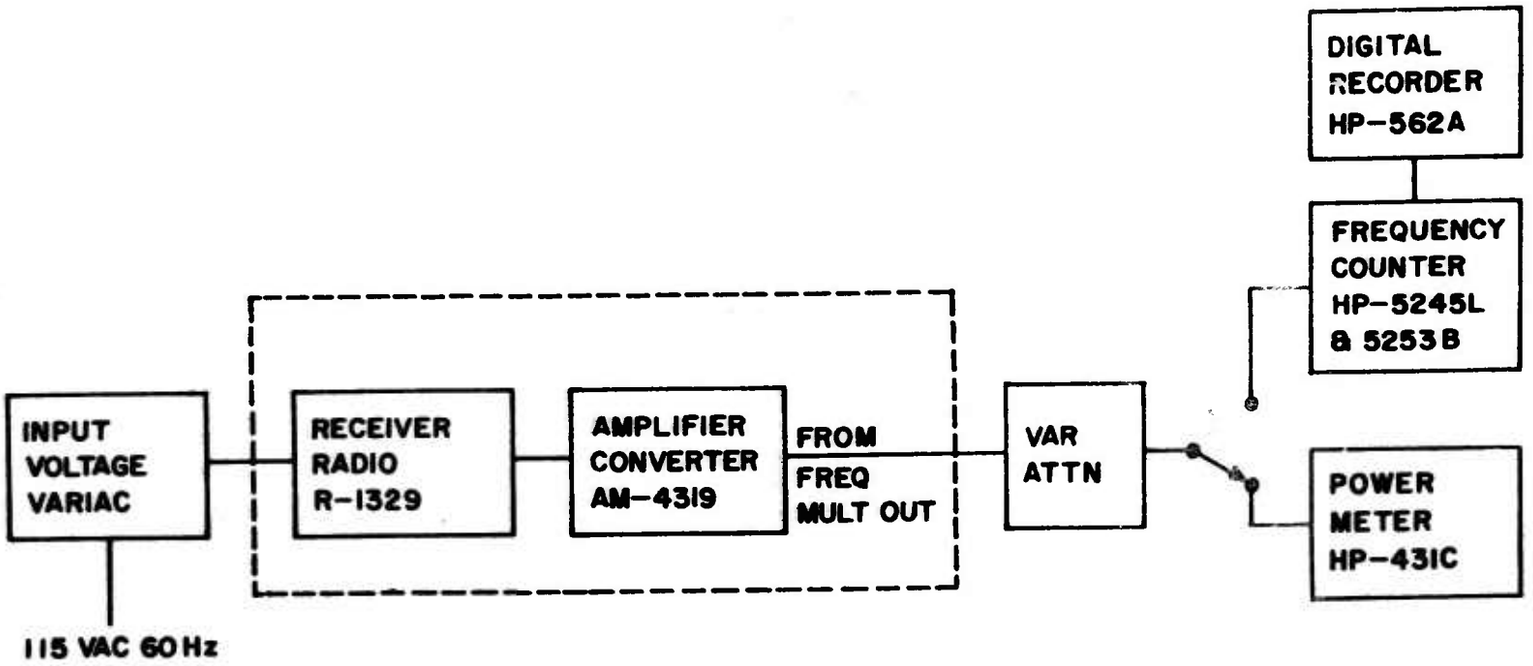


Figure 9. Test setup for receiver frequency settability and stability.

2.16.5 Analysis

The receiver can be aligned to within 0.002 percent, ±20 kHz of the desired frequency. The test item met the criterion.

2.17 RECEIVER FREQUENCY STABILITY

2.17.1 Objective

The objective of this subtest was to determine the receiver frequency stability.

2.17.2 Criteria (EL-CP0150-0001A, para 3.13.5.4.1)

The receiver when set to any channel in the operating range, after 15 minutes warmup and at any ambient temperature between -35° and +125°F (-37.2° and +51.6°C), shall not vary beyond plus and minus 0.002 percent, ±20 kHz of that frequency during the next 8 hours. The ambient may vary up to 54°F (12°C) within the above limits during the 8-hour period.

2.17.3 Data Acquisition Procedure

a. The test setup shown in figure 9 was used.

b. The test item in this configuration was placed in an environmental chamber where the ambient air temperature was controlled as required by the specifications.

c. The receiver (SN 009) was tuned to a test frequency, and while temperature cycling the test chamber between 66° and 120°F (19° and 49°C), the local oscillator frequency was continuously monitored for the next 8 hours of receiver on-time.

2.17.4 Results

The data is voluminous and can be provided upon request, however, the receiver frequency did not vary more than ±10 kHz during the entire 8 hours.

2.17.5 Analysis

The ambient temperature did not vary more than the specified limits of ±0.002 percent ±20 kHz. The test item met the criteria.

2.18 RECEIVER IF BANDWIDTH

2.18.1 Objective

The objective of this subtest is to determine the IF bandwidth.

2.18.2 Criteria (EL-CP0150-0001A, para 3.13.6)

The IF selectivity shall have a nominal 3 dB bandwidth of 750 kHz with the response down at least 60 dB at +2.1 MHz or more from resonance.

2.18.3 Data Acquisition Procedure

Contractor data was used to satisfy the subtest requirement.

2.18.4 Results

Test item SN 001 had an 842 kHz, 3 dB bandwidth and was 62 dB down at +2.1 MHz from resonance. Test item SN 002 had a 837 kHz, 3 dB bandwidth and was 64 dB down at +2.1 MHz from resonance as shown in table II.

TABLE II. IF BANDWIDTH

Serial Number	3 dB Bandwidth		Frequency Response at 30 MHz ±2.1 MHz (Ref. 30 MHz)	
	Specified	Measured	Specified	Measured
1	750 kHz Nominal	842 kHz	$\geq$ -60 dB	-62 dB
2	750 kHz Nominal	837 kHz	$\geq$ -60 dB	-64 dB

2.18.5 Analysis

The test item had the appropriate bandwidth and discrimination level. The test item met the criteria.

2.19 RECEIVER PROTECTION

2.19.1 Objective

The objective of the subtest was to determine if the receiver protective circuitry operates as required.

2.19.2 Criteria (EL-CP0150-0001A, para 3.13.7)

When subjected to an internal and external signal of at least 43 dBm, receiver protection, in the form of electronic circuitry, shall be provided so that when the transmitter has been tuned for optimum output, it shall be possible to tune the receiver duplexer section through the transmitter frequency without damage to the receiver. The circuitry shall provide protection against external signals at any frequency with a power level up to 43 dBm under all conditions of receiver tuning. The protective circuitry shall not degrade the receiver noise figure greater than 0.750 dB.

2.19.3 Data Acquisition Procedure

a. The receiver noise figure was measured as in subtest 2.13.

b. The transmitter (SN 005), interconnected to the antenna port through the duplexer, was tuned to a test frequency. The receiver was also tuned to the same test frequency. At the end of 1 minute transmit time, the transmitter was unkeyed (turned off) and the receiver noise figure again measured and recorded, providing an internal signal of at least 43 dBm.

c. The FROM XMTR connector on the receiver was terminated in a 50-ohm load, and the PWR OUT connector on the transmitter connected to the ANT terminal on the receiver. The transmitter was turned on, tuned to a test frequency, and the receiver then tuned through the transmit frequency. The transmitter was then turned off and the receiver noise figure again measured and recorded, providing an external signal of at least 43 dBm.

d. The procedure outlined in paragraph c above was performed at the test frequencies designated by asterisk (*) in paragraph 1.4c(2).

2.19.4 Results

The noise figure readings exceeded the original levels of the test frequencies by a constant 0.45 dB when subjected to an internal and external signal of at least 43 dBm.

2.19.5 Analysis

The receiver protective circuitry did not degrade the receiver noise figure greater than 0.750 dB. The test item met the criteria.

2.20 RECEIVER FREQUENCY RESPONSE

2.20.1 Objective

The objective of this subtest was to determine the receiver frequency response.

2.20.2 Criteria (EL-CP0150-0001A, para 3.13.8)

The overall frequency response of the receiver when a frequency modulated signal of constant deviation (100 kHz peak) is applied to the receiver antenna terminal and measured at the video output terminal shall conform to the following:

Mod Frequency (kHz)	Relative Attenuation (dB)		
	Nominal	Minimum	Maximum
0.125	1.0	-0.2	2.5
0.200	0.5	-0.2	1.0
0.250	0.2	-0.2	0.4
1.000	0.0	-0.1	0.1
10.000	REFERENCE	---	---
30.000	0.0	-0.1	0.1
60.000	0.15	0.05	0.25
120.000	0.6	0.2	0.9
180.000	1.3	0.8	1.8
240.000	2.3	1.8	2.8
360.000	5.1	4.4	5.8
480.000	9.0	8.2	10.0
600.000	14.0	12.5	15.5
720.000	20.2	18.4	22.6
840.000	27.5	25.3	31.0
960.000	36.0	33.0	40.0

2.20.3 Data Acquisition Procedure

a. The test setup is shown in figure 10.

b. The coaxial switch S1 was set to position 1; the output of the test oscillator was OFF; the signal generator was tuned to 30 MHz below the receiver frequency and its output was adjusted to produce a noise-quieting reading of -33 dBm, as read on the VTVM. The receiver was tuned to the center of the passband bounded by the operation of the low signal alarm.

c. The coaxial switch S1 was set to position 2 and the variable attenuator was set to 0 dB, the test oscillator was tuned to 10 kHz, and the output level was adjusted to 0.3 volt rms.

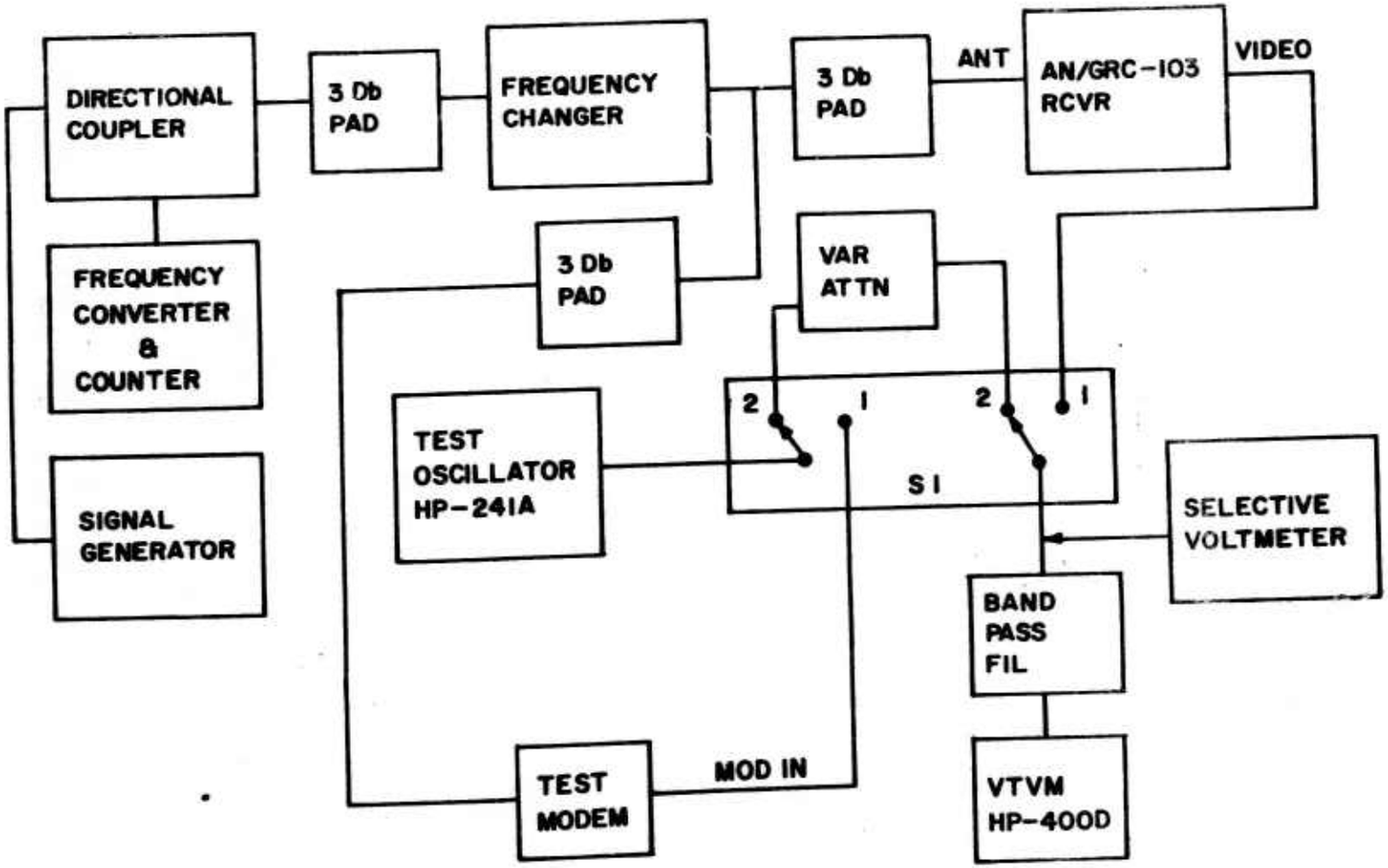


Figure 10. Test setup for receiver frequency response.

d. The coaxial switch was set to position 1, the test modem was set to 100 kHz peak deviation, and the video output level was monitored and recorded.

e. The coaxial switch was set to position 2, and the variable attenuator was adjusted until the VTVM showed the same level as when the coaxial switch was in position 1. The attenuator setting is the reference at 10 kHz.

f. The test oscillator was tuned to each of the modulating frequencies specified in the criteria and the procedure described above was repeated at each modulating frequency. At each new attenuator setting, the reading was monitored and recorded.

g. The selective voltmeter was used in place of the bandpass filter and VTVM for modulating frequencies above 10 kHz.

h. The procedures described above were performed at test frequencies of 1350, 1577, 1668, and 1850 MHz.

2.20.4 Results

The data is voluminous and can be provided upon request, however, the data collected was within the maximum and minimum relative attenuation for all test modulating frequencies.

2.20.5 Analysis

The overall frequency response of the receiver met the criteria.

2.21 RECEIVER OUTPUT IMPEDANCE

2.21.1 Objective

The objective of this subtest was to determine the receiver output impedance.

2.21.2 Criteria (EL-CP0150-0001A, para 3.13.11)

The output impedances of the receiver shall be 91 ohms ±5 percent resistive to at least 1 MHz for the regenerated 6/12-channel PCM output and 51 ohms ±10 percent resistive for the 24-channel PCM output to at least 800 kHz.

2.21.3 Data Acquisition Procedure

a. The test setup is shown in figure 11.

b. The transmitter (SN 006) was tuned to a test frequency and its output power optimized.

c. The receiver RF input signal level was adjusted to approximately -86 dBm. This level was determined by observing the amount of receiver quieting at the video output.

d. The test oscillator was tuned to each of the test modulating frequencies as follows: 0.5, 50.0, 200.0, 500.0, and 800.0 kHz. At each modulating frequency the procedure was as follows:

(1) The test oscillator was maintained at a level of 0.354 volt.

(2) The transmitter input level control was adjusted to provide 100 kHz deviation of the transmitted signal as indicated on the deviation meter.

(3) The receiver video output level (unterminated) was noted and recorded.

(4) The resistor decade box was then shunted across the video output and adjusted to produce half the voltage level recorded in paragraph (3) above. The output impedance was then read off the settings of the decade box.

2.21.4 Results

a. A practical method for measuring the regenerated 6/12-channel PCM output impedance is not known. The approved engineering design test plan does not include this test.

b. The 24-channel PCM output impedance is shown in table III.

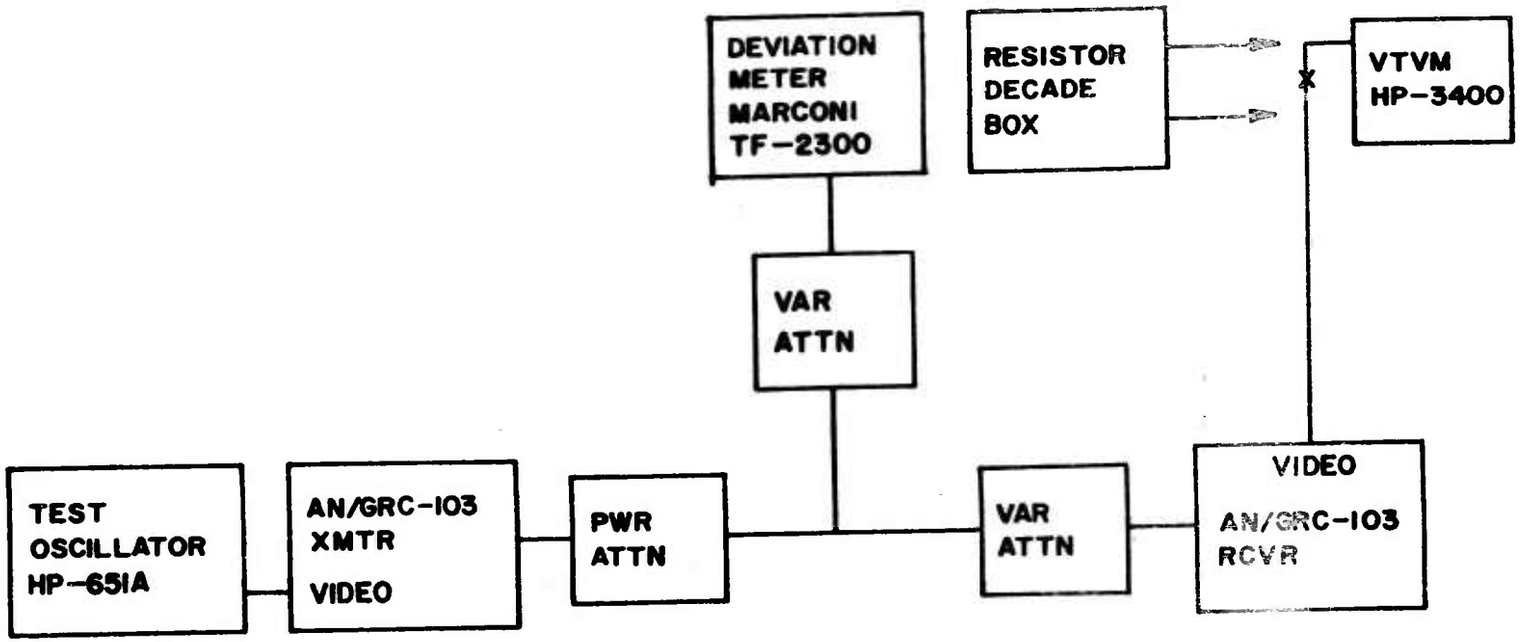


Figure 11. Test setup for receiver output impedance.

TABLE III. RECEIVER OUTPUT IMPEDANCE RESULTS (24-CHANNEL)
(SN 0012/0002)

Test Frequency	Oscillator Frequency (kHz)	Impedance (ohms)
2300	0.5	54
	50.0	54
	200.0	52
	500.0	51
	800.0	50
2672	0.5	54
	50.0	53
	200.0	52
	500.0	51
	800.0	50
2964	0.5	53
	50.0	52
	200.0	51
	500.0	50
	800.0	49
3110	0.5	52
	50.0	51
	200.0	50
	500.0	49
	800.0	48

2.21.5 Analysis

The output impedances of the receiver were within the specified limits of the test. The test item met the criteria.

2.22 RECEIVER SQUELCH AND ALARM

2.22.1 Objective

The objective of this subtest was to determine if the receiver squelch circuitry and low signal alarm operate as required.

2.22.2 Criteria (EL-CP0150-0001A, para 3.13.16.3)

A squelch shall disable the regenerated PCM signal when the signal-to-noise ratio at the unregenerated video output is less than 7 ±2 dB with a reference deviation of ±180 kHz peak. An audible and visible alarm shall operate in conjunction with the squelch to indicate locally a failure of the received signal from the remote station. A reversing switch shall be provided on the front panel such that regardless of the level of signal input to the receiver, the audible alarm can be disabled. The sensitivity of the squelch circuit shall be such that the point of operation which indicates a received signal (lamp extinguished) shall be -98 dBm ±3 dB.

2.22.3 Data Acquisition Procedure

a. The test setup is shown in figure 12.

b. The radio set (SN 008) and test equipment was turned on and allowed 15 minutes warmup.

c. The HP-608 signal generator was tuned to 50 MHz using the electronic counter, and its output adjusted to -10 dBm.

d. The transmitter was tuned to channel 2620 and the receiver to channel 2720.

e. The electronic counter was connected to the HP-614A and the generator frequency was set to the receiver tuned frequency within 20 kHz. The generator output was adjusted to -10 dBm. (NOTE: A power meter was used for this calibration.)

f. The transmitter output was temporarily disconnected from the transmitter and the HP-614A was connected to the antenna terminal of the receiver. The signal generator output level was adjusted to -74 dBm and the noise level (video output) at this level of RF input was recorded.

g. The signal generator was disconnected and the transmitter reconnected to the test setup. The modulation to the transmitter was disabled and the HP-608 output level was adjusted to obtain the same noise level at the receiver video output as in step f above.

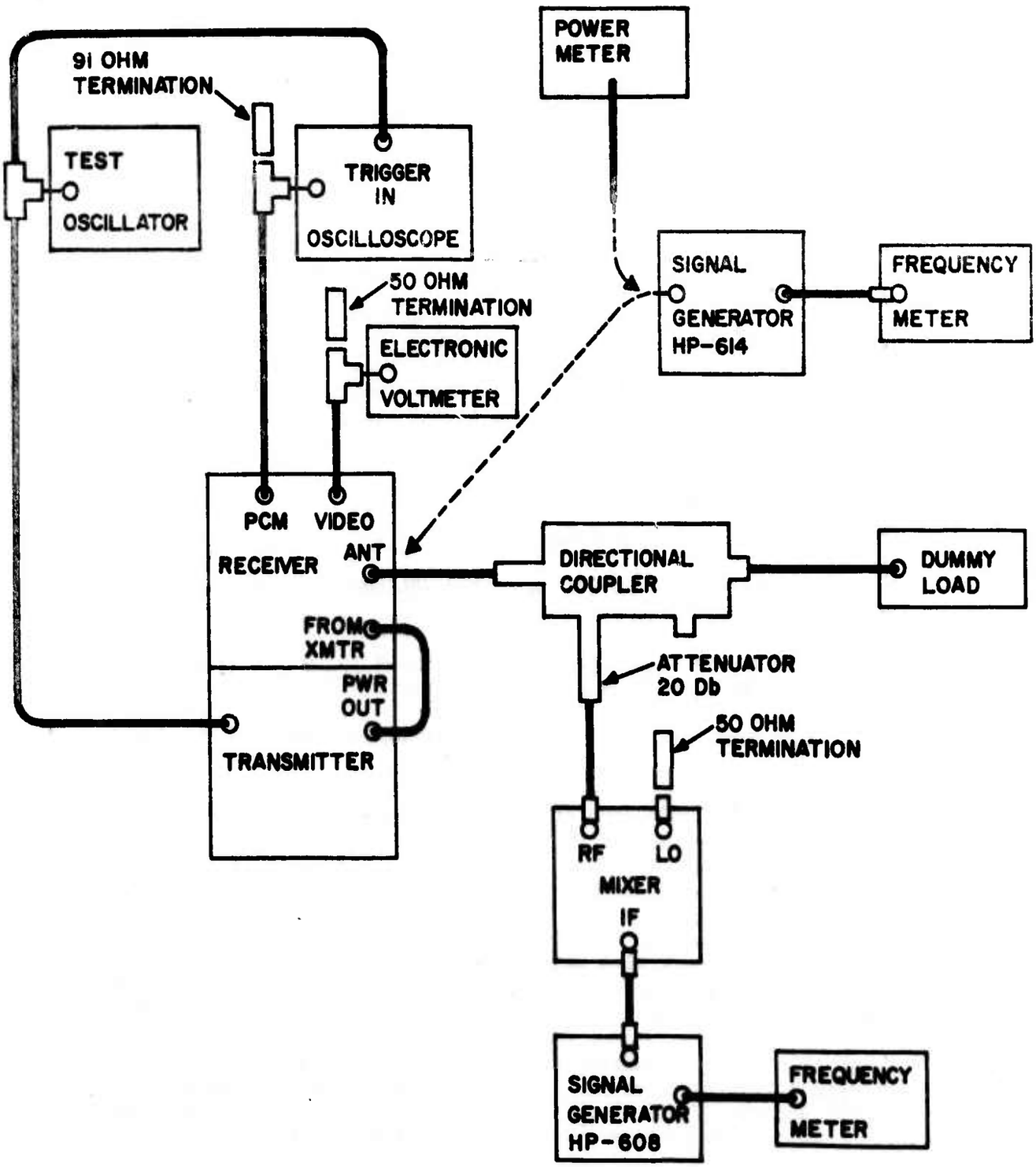


Figure 12. Test setup for receiver squelch and alarm.

h. The test oscillator frequency was set to 10 kHz and the transmitter video input level control was modulated to 50 percent indication on the panel meter in the 12 CH PCM position of the selector switch. The receiver video output reading was recorded as the reference.

i. The oscilloscope controls were adjusted as follows:

TRIGGER SLOPE	EXT +
TRIGGER MODE	AUTO +
TIME BASE	0.1 msec
AMPLIFIER	0.5 V/cm DC

Display the PCM signal on the screen.

j. The receiver RF input level was slowly decreased by decreasing the HP-608 signal generator output, until the displayed PCM signal disappeared. The buzzer sounded and the low signal lamp came ON. The buzzer was then silenced. The test oscillator was disconnected from the transmitter and the noise level, which was indicated on the electronic voltmeter, was recorded. The signal-to-noise ratio was between 5 and 9 dB.

k. The test oscillator was reconnected and the receiver RF input level was slowly increased until the PCM signal reappeared on the screen. The buzzer sounded and the alarm light went out. The noise level indicated just before the signal output was restored was recorded.

l. The transmitter was switched OFF and the HP-614A signal generator was connected to the receiver antenna terminal. The signal generator output was adjusted to obtain the same noise level as in step k above. The signal generator output was between -95 and -101 dBm at this point.

2.22.4 Results

a. The PCM output was lost when the RF input signal level was -102 dBm.

b. The alarm circuitry operated when the RF input signal level was -100 dBm.

c. The sensitivity of the alarm circuitry is -100 dB.

d. The signal-to-noise ratio of the video output is +8 dB.

2.22.5 Analysis

The receiver squelch and alarm operated within the specified limits. The criteria were met.

2.23 PCM OPERATION

2.23.1 Objective

The objective of this subtest was to determine if the radio set is capable of transmission of specified PCM signals.

2.23.2 Criteria (EL-CP0150-0001A), para 3.13.10)

The radio set shall provide for transmission of signals from Multiplexers TD-352, TD-353, TD-660, and TD-754. These signals are briefly described below:

PCM Characteristics

Number of channels	6	12	24
Signal Form	(Full-band, Unipolar Binary)		(Biternary combination of two 12 channel signals)
Bit Rate	288 kHz	288 kHz	576 kHz
Pulse width at half amplitude	3.472 µsec	3.472 µsec	1.736 µsec

2.23.3 Data Acquisition Procedure

a. The test setup is shown in figure 13.

b. The system was operated for 2 hours under each of the conditions described below:

(1) The transmitters (SN 008) at each end of the circuit were tuned to a test channel (50 channel separation); and each receiver was correspondingly tuned to the opposite end transmitter.

(2) The RF signal level input at each receiver was attenuated to produce receiver quieting of -26 dBm, as indicated on the VTVM.

(3) PCM signal traffic was injected at both ends of the configuration, and channel levels and distortion measurements were recorded. These measurements were performed at both 12- and 24-channel operation. The test setup shows the configuration for 24-channel operation. For 12-channel, the TD-660 (slave) and the TD-202 combiner were taken out of the circuit.

(4) The PCM characteristics were examined by observing the operation on the oscilloscope.

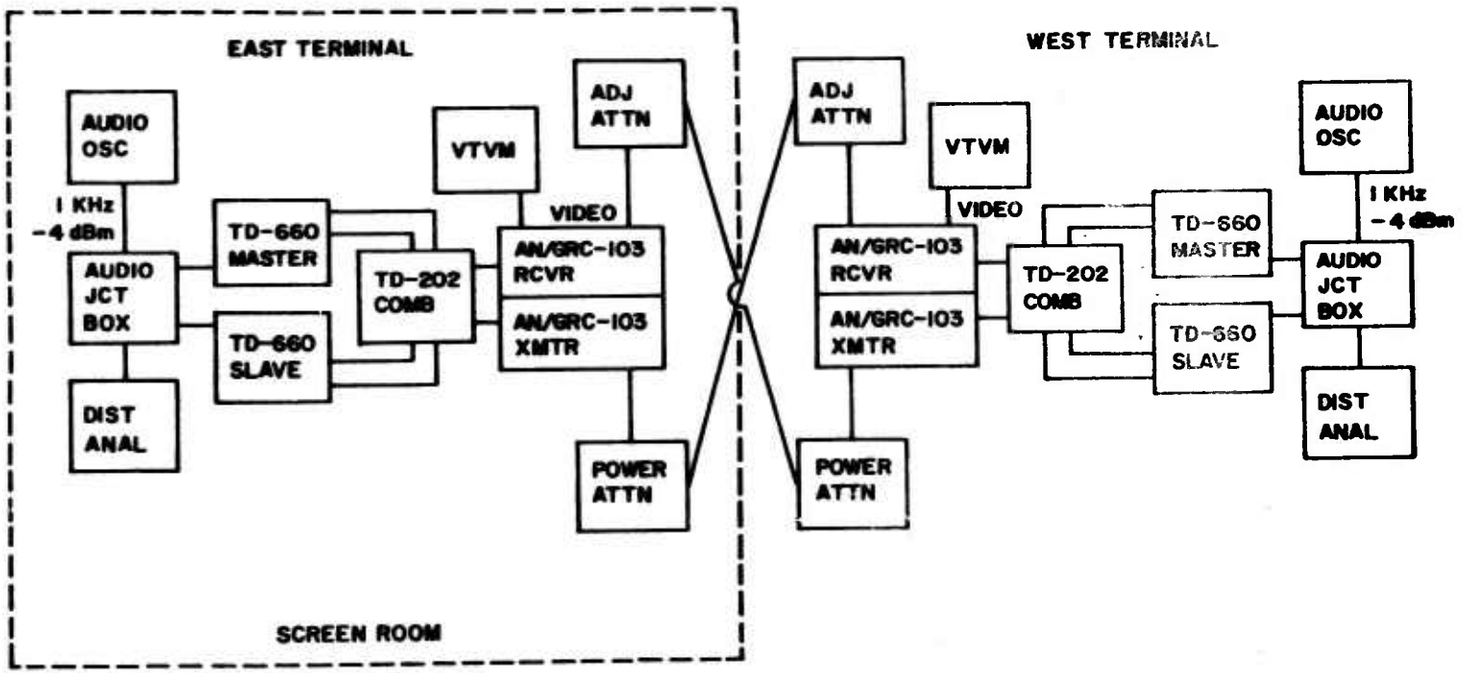


Figure 13. Test setup for pulse code modulation operation.

2.23.4 Results

The data is voluminous and can be provided upon request, however, the distortion measurements and signal levels showed that the test item will pass PCM traffic.

2.23.5 Analysis

The test item does provide for transmission of PCM traffic. The test item met the criteria.

2.24 FREQUENCY RESPONSE (PCM)

2.24.1 Objective

The objective of this subtest was to determine the frequency response between the transmitter video input and the receiver video output.

2.24.2 Criteria (EL-CP0150-0001A, para 3.13.12)

The overall frequency response between transmitter video input and receiver video output relative to the response at 10 kHz shall conform to the following:

Modulation Frequency (kHz)		PCM Frequency Response in Decibels		
		Nominal	Minimum	Maximum
0.125		2.0	1.0	3.0
0.200		1.0	0.0	2.0
0.250		0.4	0.0	0.8
0.500		0.0	-0.1	+0.1
1.000		0.0	-0.1	+0.1
10.000	REFERENCE	0.0	0.0	0.0
30.000		0.0	-0.1	0.2
60.000		0.2	0.1	0.4
120.000		0.7	0.5	1.0
180.000		1.6	1.3	2.2
240.000		2.9	2.5	4.0
360.000		6.5	5.7	8.0
480.000		11.7	10.2	13.5
600.000		18.2	16.0	21.0
720.000		26.2	23.1	30.5
840.000		35.7	31.7	41.0
960.000		46.7	41.2	52.5

2.24.3 Data Acquisition Procedure

a. The test setup is shown in figure 14.

b. The coaxial switch was set to position 1, and the test oscillator was tuned to 10 kHz, the transmitter to channel 2740, and the receiver to channel 2840.

c. With the transmitter panel meter in the 12 channel PCM mode and the test oscillator output control fully clockwise, the transmitter input level control was adjusted to yield 25 percent FSD on the transmitter panel meter.

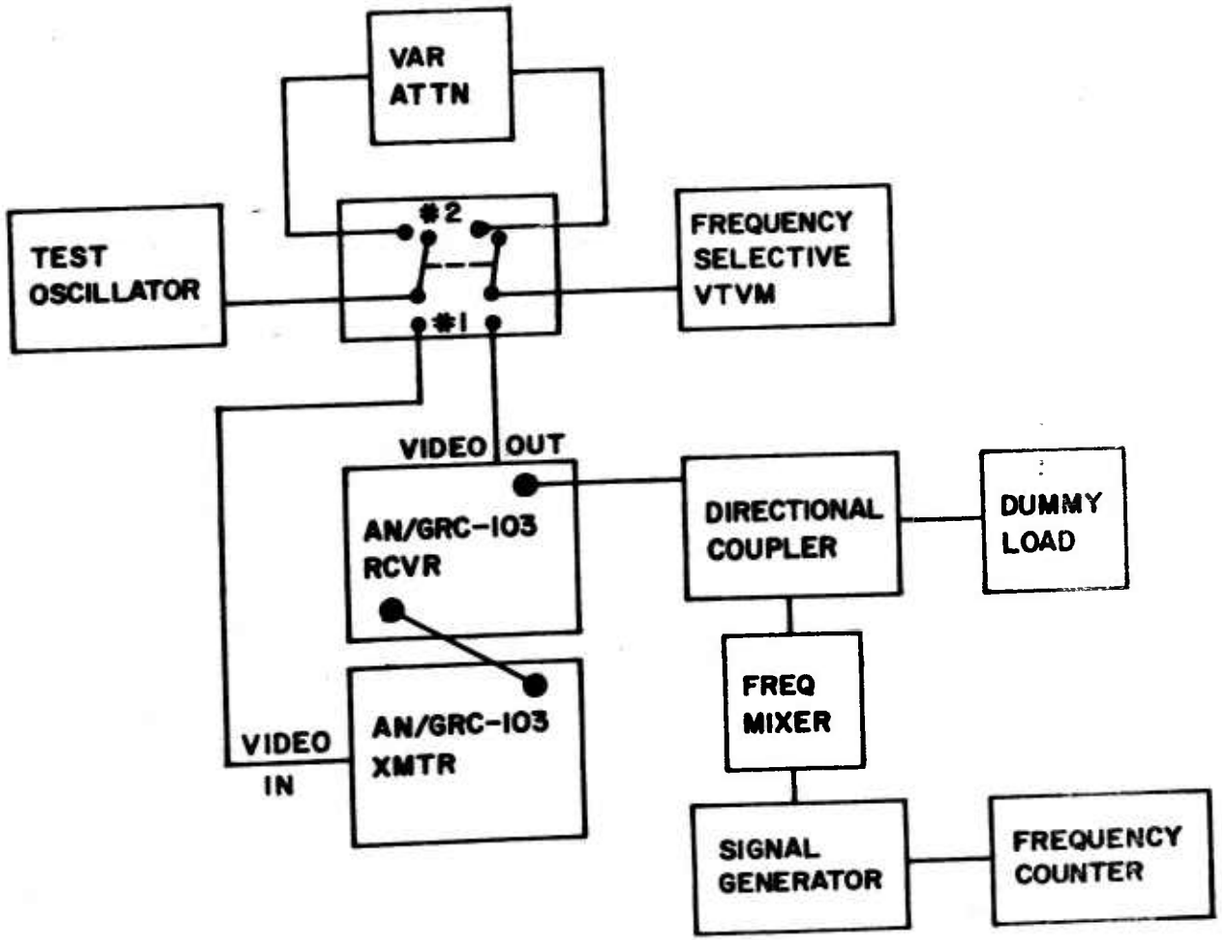


Figure 14. Test setup for system frequency response.

d. The test oscillator frequency was adjusted for a maximum indication on the wave analyzer, and the analyzer level thus obtained. was recorded.

e. The coaxial switch was set to position 2 and the variable attenuator was adjusted to obtain the same reading as recorded in d above. The variable attenuator reading was recorded for reference at the modulating frequency of 10.0 kHz.

f. Maintaining the test oscillator output level and the transmitter input level control constant, the test oscillator was tuned to the frequencies indicated in the criteria and the procedure above was repeated at each test frequency.

g. Test channels 2672 and 3110 were also utilized.

2.24.4 Results

See table IV.

2.24.5 Analysis

The test items SN 011 and 009 performed within the criteria.

TABLE IV. BAND IV FREQUENCY RESPONSE (PCM) RESULTS

XMTR Chan	Rec Chan	Mod Freq. (kHz)	Relative PCM Frequency Response (dB)	
2740	2840	.125	1.90	
		.200	0.90	
		.250	0.3	
		.500	0.0	
		1.000	0.0	
		10.00	0.0	Reference
		30.00	0.1	
		60.00	0.3	
		120.0	0.8	
		180.0	1.7	
		240.0	3.0	
		360.0	6.6	
		480.0	11.8	
		600.0	18.2	
		720.0	26.3	
		840.0	35.8	
		960.0	46.8	
2672	3110	.125	2.1	
		.200	1.1	
		.250	0.5	
		.500	0.1	
		1.000	0.0	
		10.00	0.0	Reference
		30.00	0.1	
		60.00	0.3	
		120.0	0.8	
		180.0	1.7	
		240.0	3.1	
		360.0	6.7	
		480.0	11.9	
		600.0	18.4	
		720.0	26.4	
		840.0	35.9	
		960.0	46.9	

2.25 PCM MODULATION REQUIREMENTS

2.25.1 Objective

The objective of this subtest was to determine if the radio set under test meets the PCM modulation requirements.

2.25.2 Criteria (EL-CP0150-0001A, para 3.13.13)

The type of modulation used in the transmitter shall be frequency modulation. The rated peak deviation of the transmitter shall be plus and minus 300 kHz. The modulation deviation of the transmitter shall be continuously variable with the maximum deviation of plus and minus 300 kHz peak with an input voltage of 1 volt peak-to-peak. The receiver regenerated output shall be 2 volts ±10 percent when receiving a signal with peak deviation plus and minus 180 kHz. The receiver unregenerated output shall be 0.75 volt ±0.25 volt peak-to-peak when receiving a signal with the rated peak deviation plus and minus 300 kHz.

2.25.3 Data Acquisition Procedure

a. The test setup is shown in figure 15.

b. The RF output terminal of the receiver was connected, through sufficient attenuation, to the receiver antenna terminal and a Marconi TF-2300 deviation meter. A HP 651B oscillator and a HP 400 VTVM were connected to the video input terminal of the transmitter. The video output and PCM output of the receiver were connected to a Tektronix 545 oscilloscope and terminated in 50 and 91 ohm terminations respectively. The FRM XMTR terminal of the receiver was terminated in 50 ohms.

c. The transmitter input control was turned completely clockwise, the transmitter and receiver tuned to the test frequency, a 10 kHz, 0.354 volt (rms) signal applied to the video input and the deviation measured at the receiver antenna terminal.

d. The transmitter input signal was adjusted to yield plus and minus 180 kHz deviation and the signal level at the video and PCM outputs of the receiver was measured in peak-to-peak volts. NOTE: Alternate Video In was used when checking regenerated PCM operation.

e. The methods above were performed at the test frequencies listed in paragraph 1.4c.

2.25.4 Results

a. The peak deviation of the transmitter was ±285 kHz at peak output.

b. With a 1-volt peak to peak input voltage, the modulation deviation was continuously variable with a maximum deviation of ±285 kHz.

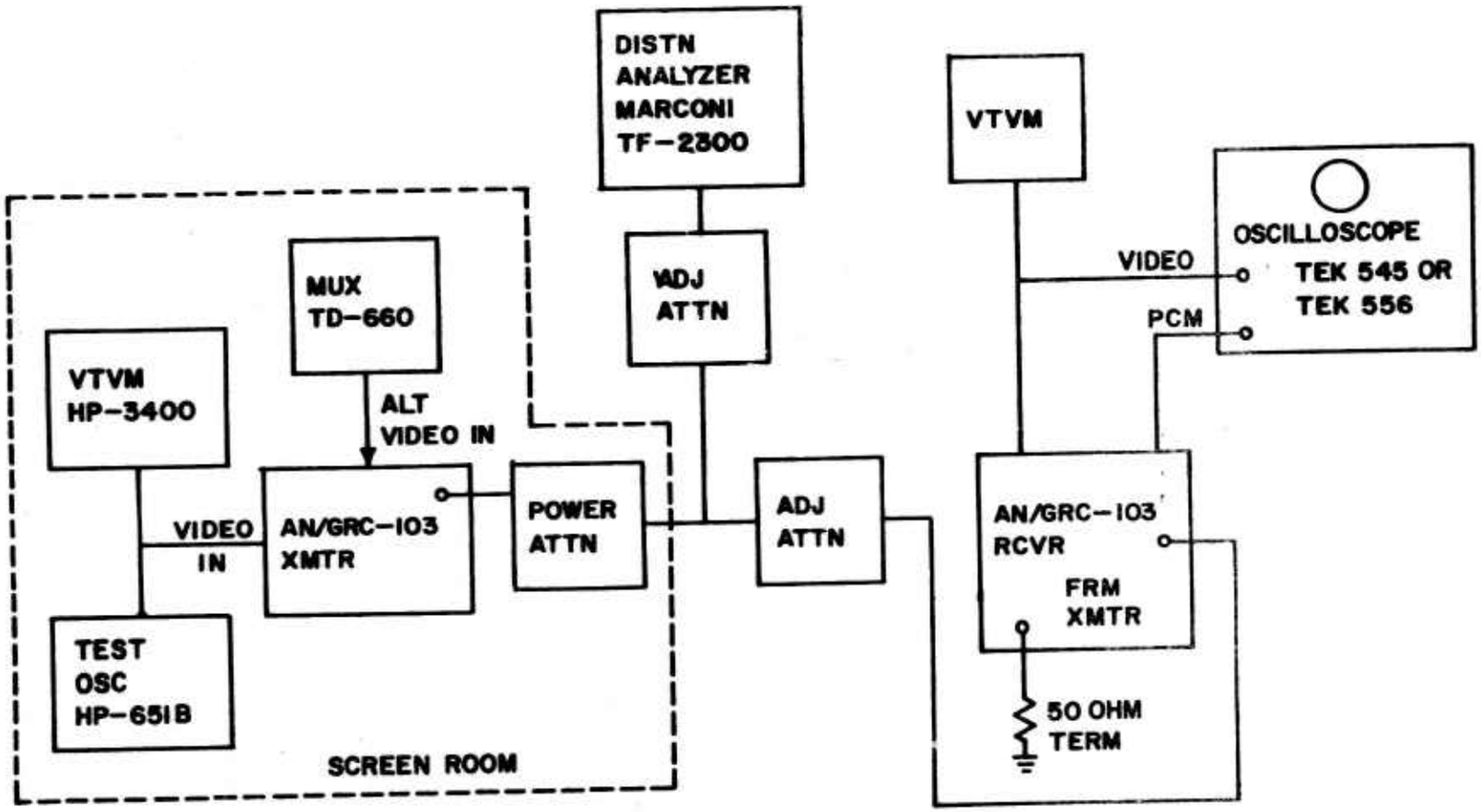


Figure 15. Test setup for PCM modulation requirements and metering circuitry.

c. The receiver regenerated output varied from 2.1 volts to 1.9 volts at a ±180 kHz peak deviation.

d. The receiver unregenerated output varied between .54 volt and .9 volt at a peak deviation of ±300 kHz.

2.25.5 Analysis

The transmitter achieved a maximum deviation of ±285 kHz when a 1 volt peak-to-peak input was used; however, when the TD-660 was used, a ±300 kHz deviation was achieved.

The test item (SN 0011) meets the PCM modulation requirements.

2.26 PCM METERING CIRCUITRY

2.26.1 Objective

The objective of this subtest was to determine if the PCM metering circuitry operates as required.

2.26.2 Criteria (EL-CP0150-0001A, para 3.13.13)

Metering circuitry shall be provided in the equipment to enable the operator to perform the following in the absence of external test equipment:

a. Adjust the peak deviation of the transmitter to plus and minus 180 kHz and plus and minus 300 kHz with an accuracy of plus 2.2 and minus 1.0 dB with inputs from 1 to 4 volts (peak-to-peak).

b. Establish that the regenerated receiver output is 2 volts ±10 percent when receiving a signal with peak deviation of plus and minus 180 kHz, and that the unregenerated receiver output is 0.75 ±0.25 volts (peak-to-peak) when receiving a signal with peak deviation of plus and minus 300 kHz.

2.26.3 Data Acquisition Procedure

a. The equipment will be connected as in figure 15.

b. The receiver and transmitter were tuned to the test frequency, the meter select switch on the transmitter set to 24 channel, a 0.35 volt (rms), 10 kHz signal was applied to the video input, the meter adjusted to the central reference in the green band with the INPUT control, and the frequency deviation was measured.

c. The transmitter meter select switch was set to 12 channel, the meter was adjusted to the central reference in the green band with the INPUT control and the frequency deviation were measured.

d. The receiver meter select switch was set to 12 channel, the transmitter was adjusted to plus and minus 180 kHz deviation, the receiver PCM output was measured in volts (peak-to-peak), and the position of the receiver panel meter indicator was noted.

e. The receiver meter select switch was set to 24 channel, the transmitter was adjusted to plus and minus 300 kHz deviation, the receiver video output was measured in volts (peak-to-peak) and the position of the receiver panel meter indicator in volts peak-to-peak was noted and recorded.

f. The methods above were performed at the test frequencies designated by an asterisk (*) in paragraph 1.4c.

2.26.4 Results

a. The peak deviation of the transmitter could be adjusted to ±180 kHz and ±300 kHz through the use of the internal metering circuitry.

b. Through the use of the internal metering circuitry, it could be established that the regenerated receiver output was 2 volts ±10 percent when receiving a signal with a peak deviation of ±180 kHz and that the unregenerated output was between .50 volt and 1.0 volt with a signal that had a peak deviation of ±300 kHz.

Transmitter Test Frequency	Meter Position		Deviation (kHz)	Receiver Output (P-P Volts)	Meter Select Switch Position
	Receiver	Transmitter			
2300	Center	Center	±180	2.1	12 chnl PCM
2672	Center	Center	±180	2.0	12 chnl PCM
2964	Center	Center	±180	2.0	12 chnl PCM
3110	Center	Center	±180	2.1	12 chnl PCM
2300	Center	Center	±300	.80	24 chnl PCM
2672	Center	Center	±300	.70	24 chnl PCM
2964	Center	Center	±300	.70	24 chnl PCM
3110	Center	Center	±300	.80	24 chnl PC,

2.26.5 Analysis

The PCM metering circuitry operates as required.

2.27 SIGNAL-TO-NOISE (PCM)

2.27.1 Objective

The objective of this subtest was to determine the signal-to-noise ratio.

2.27.2 Criteria (EL-CP0150-0001A, para 3.13.14)

The transmitter shall be adjusted for a peak deviation of plus and minus 180 kHz. Under these conditions, the ratio of average detected signal power to the average noise power at the unregenerated video output terminal of the receiver shall be at least 12 dB when the received RF signal is -94 dBm, and at least 31 dB when the received RF signal is -74 dBm. The transmitter shall be adjusted for rated peak deviation (plus and minus 300 kHz), the ratio shall be at least 16 dB when the received RF signal is -94 dBm, and at least 35 dB when the received signal is -74 dBm.

2.27.3 Data Acquisition Procedure

a. See figure 15 for test setup.

b. The transmitter (SN 005) was connected, through a 50 dB power attenuator, an HP 355C and a HP 355D, to the receiver antenna terminal, a Marconi TF-2300 deviation meter and a HP 410B RF VTVM. A HP 651B was connected to the video input of the transmitter and a HP 400 VTVM, HP 908A termination and a Tektronix 545 oscilloscope was connected to the video output of the receiver. The FRM XMTR terminal of the receiver was terminated in 50 ohms.

c. The transmitter and receiver were tuned to the test frequency, a 10 kHz signal applied to the transmitter, the transmitter RF output deviated plus and minus 180 kHz, the receiver to transmitter attenuation was adjusted to give a -94 dBm signal at the antenna terminal and signal level at the receiver video output voltage measured in decibels and peak-to-peak volts.

d. The 10 kHz signal at the transmitter input was removed and the noise level at the receiver video output measured in decibels.

e. Methods b and c were repeated adjusting the RF input at the receiver antenna terminal to -74 dBm.

f. Methods b, c and d were performed with the transmitter output deviated plus and minus 300 kHz.

g. The procedure above was performed at the test frequencies listed in paragraph 1.4c.

2.27.4 Results

See table V.

2.27.5 Analysis

The test items (Rec SN 009 and trans SN 011) performed well within the criteria.

TABLE V. BAND IV SIGNAL TO NOISE (PCM) RESULTS

Channel No.	Signal to Noise Ratio AT ±180 kHz Deviation (dBm)	Signal to Noise Ratio at ±300 kHz Deviation (dBm)
2300	38.7	42.5
2391	49.5	43.6
2500	36.5	40.5
2671	39.0	43.2
2700	38.3	40.7
2818	38.0	42.5
2891	38.5	44.0
2900	35.5	38.5
2961	38.5	43.0
2964	38.0	43.0
3037	39.0	43.5
3100	38.0	42.0
3110	38.0	42.0
3197	37.5	42.0
3257	37.0	42.0
3277	37.5	43.0
3299	38.0	42.0
2300	39.4	43.3
2391	39.5	43.3
2500	36.5	42.0
2671	39.8	43.9
2700	38.8	42.7
2818	38.5	44.0
2891	40.0	44.0
2900	41.0	43.5
2961	39.4	44.0
2964	39.7	44.0
3037	39.0	45.0
3100	39.0	43.0
3110	39.0	43.0
3197	38.5	44.0
3257	39.0	44.0
3277	39.0	43.0
3299	39.0	43.0

2.28 DISTORTION (PCM)

2.28.1 Objective

The objective of this subtest was to determine the harmonic distortion produced by the radio set.

2.28.2 Criteria (EL-CP0150-0001A, para 3.13.15)

The total harmonic distortion at any frequency between 250 Hz to 240 kHz, measured at the unregenerated video output terminal shall not exceed a level 26 dB below the fundamental of 10 kHz.

2.28.3 Data Acquisition Procedure

a. The equipment was set up as in figure 16 with a HP 334A distortion analyzer replacing the HP 400 VTVM at the receiver video output.

b. The transmitter and receiver were tuned to the test frequency, a 10 kHz tone was applied to the transmitter and its level adjusted to give plus and minus 300 kHz of deviation, the RF output attenuated to -54 dBm at the receiver antenna terminal, the peak-to-peak voltage and total harmonic distortion were measured at the receiver video output.

c. The methods above were performed at the test frequencies designated by an asterisk in paragraph 1.4c(2).

2.28.4 Results

See table VI.

2.28.5 Analysis

The distortion at no time exceeded a level greater than 26 dB below the fundamental of 10 kHz. The test item met the criteria.

TABLE VI. BAND IV DISTORTION (PCM) RESULTS

Channel No.	P-P Volts	Dist - 10 Hz (dB)	Dist - 250 Hz (dB)	Dist - 240 kHz (dB)
3100	.8	-60	-70	-80
2964	.75	-36	-46	-54
2672	.95	-34	-43	-54
2300	.95	-38.5	-47	-55

2.29 REGENERATED PCM

2.29.1 Objective

The objective of this subtest was to determine if the pulse regeneration circuitry functions as required.

2.29.2 Criteria (EL-CP-0150-0001A, para 3.13.16)

The regeneration shall eliminate all noise peaks less than 40 percent of the pulse amplitude for the range of unregenerated video output levels corresponding to input deviations of plus and minus 145 kHz peak minimum to plus and minus 230 kHz peak maximum. The regenerated signal amplitude shall be -0.1 +0.1 volt for the '1' condition and -2.0 ±0.2 volts for the '0' condition, delivered into a load of 91 ohms ±5 percent with no reversal of phase from the transmitter input or unregenerated video output. Pulse width shall be full interval with 10 to 90 percent rise time of 20.0 nanoseconds (nsec) minimum, 50 nsec maximum. The 50 percent point shall be 0 nsec minimum, 80 nsec maximum after the 50 percent point of the rising edge of the timing signal specified below. The timing signal amplitude shall be 2.0 ±0.2 Vdc isolated, delivered into a load of 91 ohms ±5 percent. Pulse width at the 50 percent amplitude point shall be 90 nsec minimum, 150 nsec maximum. Rise time of the leading edge from the 10 percent point to the 90 percent point shall be 20 nsec minimum, 50 nsec maximum. Pulse rate shall be 576 kHz for both the 6 channel and 12 channel signals.

2.29.3 Data Acquisition Procedure

a. The equipment was connected as in figure 15, the TMG output of the receiver was terminated in 91 ohms and the Tektronix 545B replaced with a TEK 7704 with oscilloscope camera installed.

b. The receiver and transmitter were tuned to any test channel, a 10 kHz signal applied to the transmitter and its level adjusted to produce plus and minus 180 kHz of deviation. The video input and video output were monitored with the oscilloscope. Both beams of the oscilloscope were triggered with the video input signal and the phase relationship of the input and output signals noted and recorded.

c. The video output and PCM output of the receiver were monitored with the oscilloscope, both beams were triggered with the PCM output signal and their phase relationship noted and recorded.

d. The PCM output and timing output of the receiver were monitored with the oscilloscope, the timing output being used as the trigger. The high and low voltage levels, rise time and time to reach 50 percent of the PCM output pulse were measured. The 50 percent point was measured with time equal to 0 being the 50 percent point of the timing pulse.

e. The pulse width at the 50 percent amplitude point, rise time, high and low voltage levels, and pulse rate of the timing signal were measured.

f. The above procedures were performed with RF frequency deviations of plus and minus 145, 180, and 230 kHz.

2.29.4 Results

The results are shown in table VII and figures 16-1, 16-2, and 16-3.

2.29.5 Analysis

The regenerated PCM and the timing pulse meet all of the dimensions in the criteria.

TABLE VII. REGENERATED PCM TEST RESULTS
(Test Freq. 1350 MHz, Chan 2300)

Deviation	Video In/Out Phase Relation	Video PCM Out Phase Relation	PCM Voltage 1/0	PCM Rise Time	PCM 50% Rise Time	Timing 50% Point Pulse Width	Timing Voltage	Timing Rise Time	Timing PRF
±180 kHz	In Phase	In Phase	-.2/-2.1	30 ns	21 ns	82 ns	2.2	20 ns	920 ns
Photo No.	A-1	A-2/A-3		A-4	A-4	A-5	A-6	A-5	
±145 kHz	In Phase	In Phase	-.2/-2.1	30 ns	20 ns	84 ns	2.2	20 ns	920 ns
Photo No.	B-1	B-2		B-3	B-3	B-4	B-5	B-4	
1230 kHz	In Phase	In Phase	-.2/-2.1	30 ns	22 ns	86 ns	2.2	22 ns	920 ns
	C-1	C-2		C-3	C-3	C-4	C-5	C-4	
Pulse Rate	576 kHz	12 channel							
	576 kHz	6 channel							

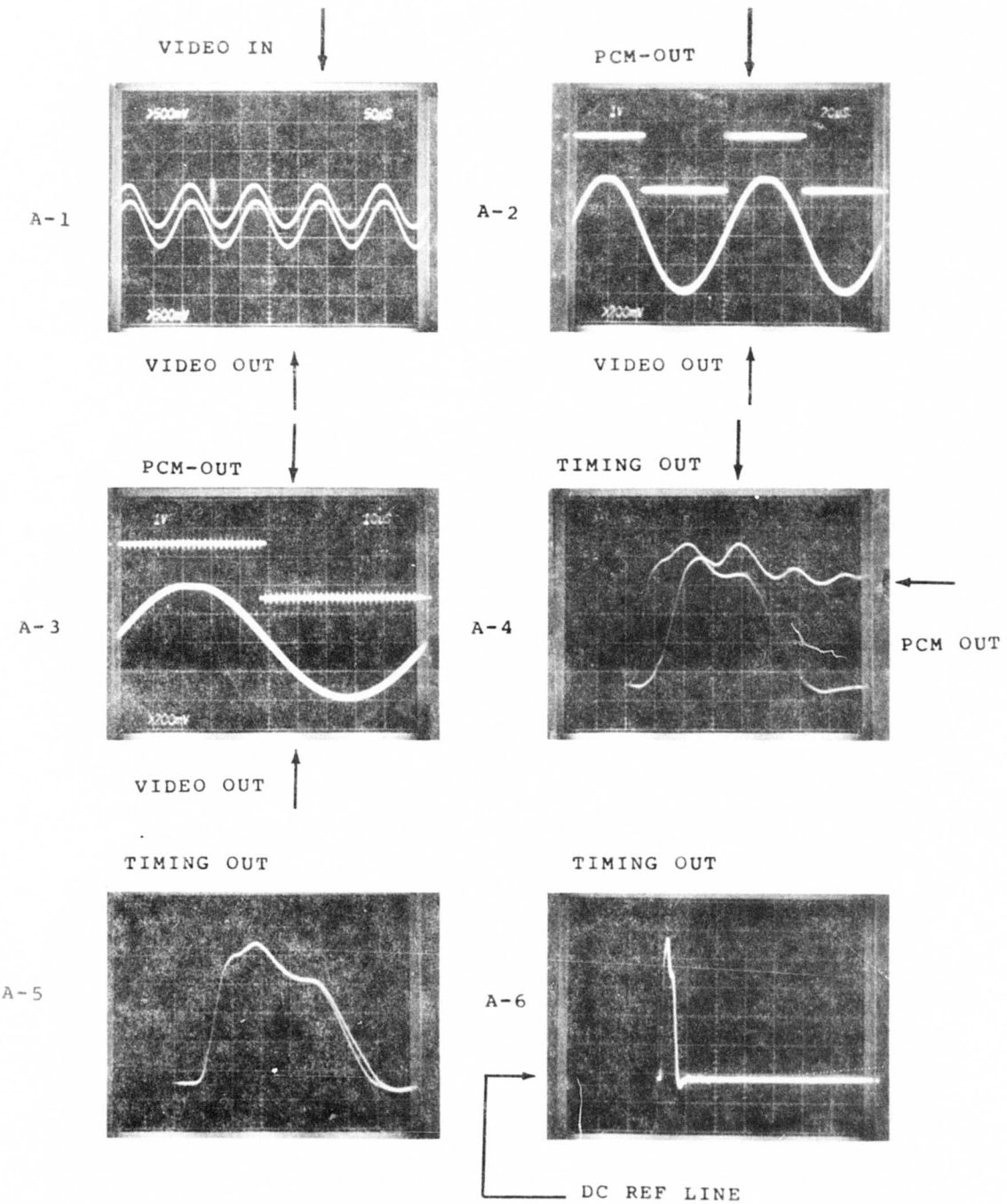


Figure 16-1. Regenerated PCM oscilloscope data.

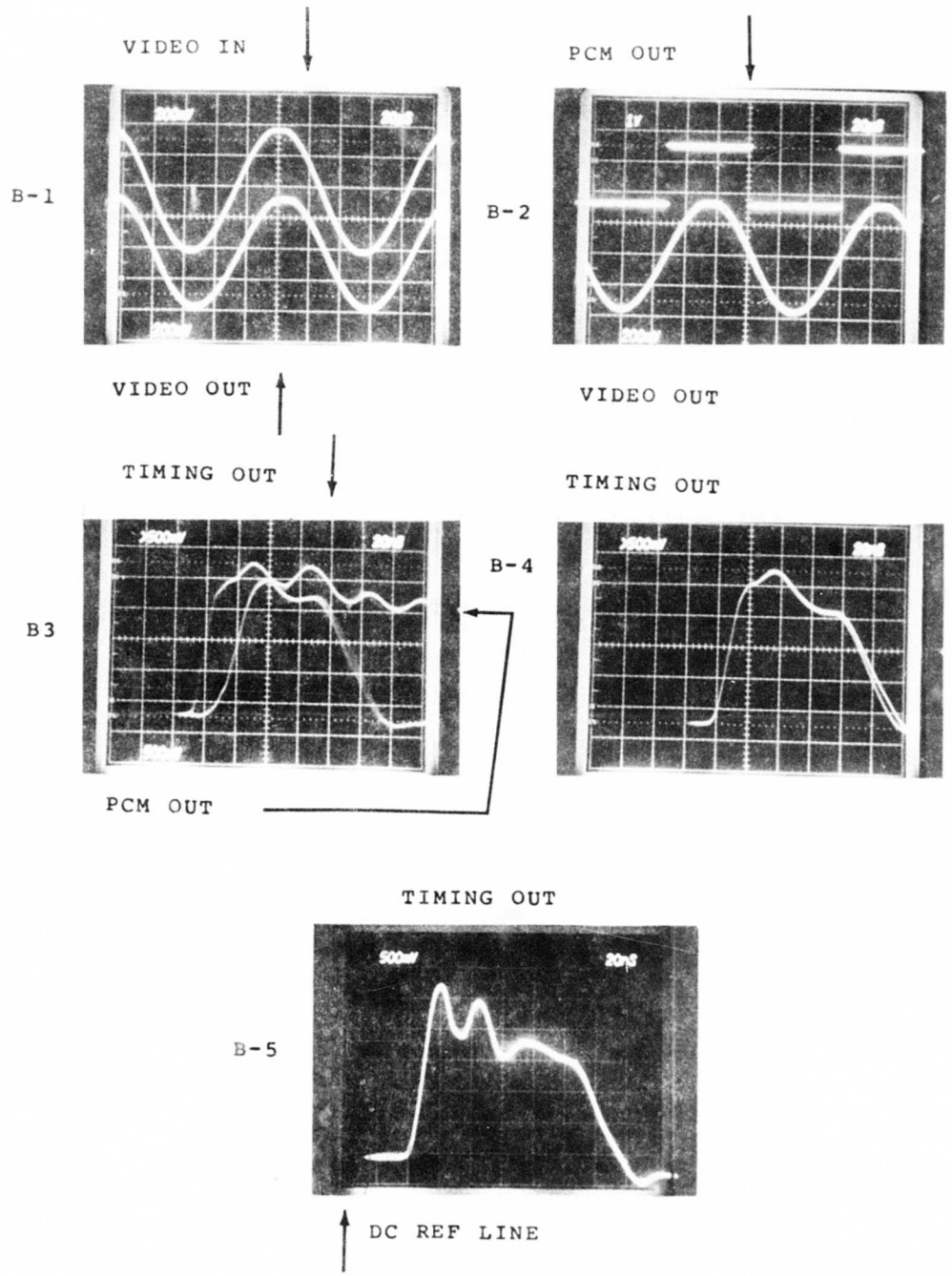


Figure 16-2. Regenerated PCM oscilloscope data.

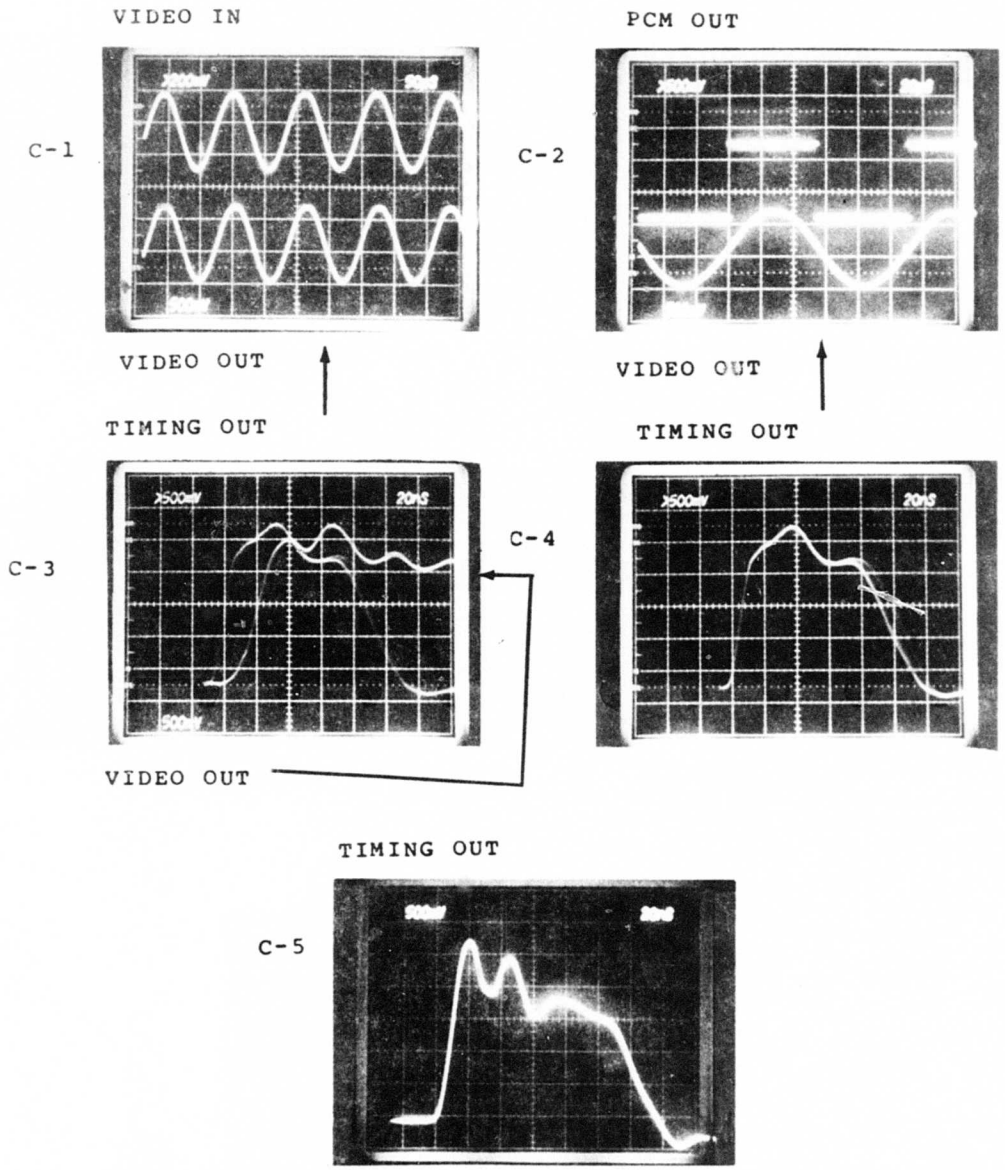


Figure 16-3. Regenerated PCM oscilloscope data.

2.30 DUPLEXER INSERTION LOSS

2.30.1 Objective

The objective of this subtest was to determine the duplexer insertion loss.

2.30.2 Criteria (EL-CP0150-0001A, para 3.13.37)

The duplexers shall have minimum pass-band insertion loss. Insertion loss at the center frequency of the pass-band of the transmitter section shall not exceed 2 dB over the operating band.

2.30.3 Data Acquisition Procedure

a. The test setup is shown in figure 17.

b. The transmitter PWR OUT was connected through the BIRD wattmeter and terminated in a dummy load.

c. The transmitter (SN 006) was tuned to a test frequency, its power output peaked, and the output as indicated on the wattmeter was recorded.

d. The transmitter output was then reconnected to feed through the duplexer to the wattmeter and dummy load. The transmitter panel meter switch was positioned to "Refl Pwr", the duplexer was tuned for a minimum reading on the transmitter panel meter, and the transmitter again tuned for maximum power output as indicated on the wattmeter. The difference between this output and the output recorded in paragraph c above was the loss through the duplexer.

e. The above procedure was performed at the test channels specified in paragraph 1.4c.

2.30.4 Results

The results are shown below. The dB losses were calculated using formula in analysis.

Channel No.	Pwr Out (W)	Loss (dB)
2300	15.0	1.35
2672	14.5	1.83
2964	15.0	1.76
3110	12.0	1.76

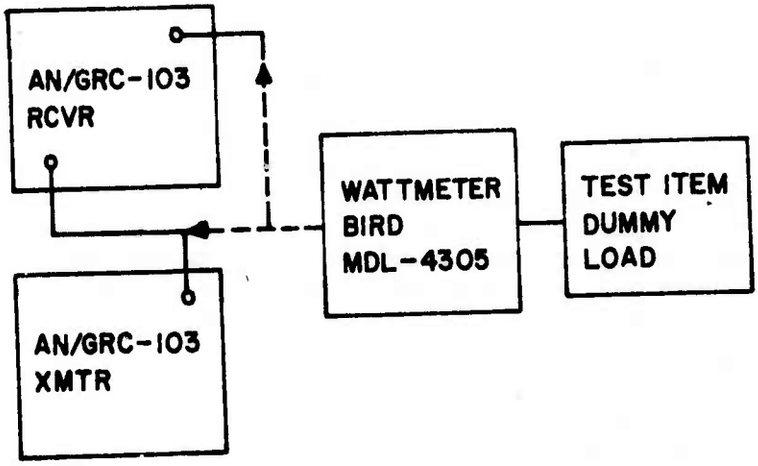


Figure 17. Test setup for duplexer insertion loss.

2.30.5 Analysis

a. $\text{Power (dBm)} = 10 \log \frac{\text{Power (watts)}}{10^{-3}}$

b. The duplexer insertion loss at the center frequency of the pass-band of the transmitter section did not exceed 2 dB over the operating band. The criteria was met.

2.31 DUPLEXER TUNING

2.31.1 Objective

The objective of this subtest was to determine if the duplexer tuning controls and metering circuits operate as specified.

2.31.2 Criteria (EL-CP0150-0001A, para 3.13.37.2)

The duplexers shall be continuously tunable over their respective frequency ranges. To facilitate tuning, metering shall be incorporated to indicated power transmitted to the antenna from the duplexer, and the power reflected from the antenna back to the duplexer. The controls shall be calibrated in channel numbers accurately enough to permit their tuning, without special equipment, to meet the operational requirements of this specification.

2.31.3 Data Acquisition Procedure

a. The test setup is shown in figure 18.

b. The transmitter (SN 008) was tuned to test channels from 2300 to 3299 in 15 channel increments, while observing and recording the operation of the channel tapes, the frequency reading, and meter readings at each test channel. Observations were made to include the following:

(1) When the transmitter was properly tuned, the duplexer channel tape did reflect the correct operating channel.

(2) When the transmitter meter switch was positioned to "Pwr Out" and "Refl Pwr", the meter reading did react in accordance with TM operating procedure information, when tuning the transmitter duplexer.

(3) When the receiver meter switch was positioned to "Xmtr Dupl" and "Refl Pwr", the meter reading did react in accordance with TM operating procedure information, when tuning the transmitter for optimum output power.

2.31.4 Results

The duplexer channel tapes and the transmitter and receiver meter readings react in accordance with information presented in the operating manual. (See table VIII.)

2.31.5 Analysis

The criteria was met.

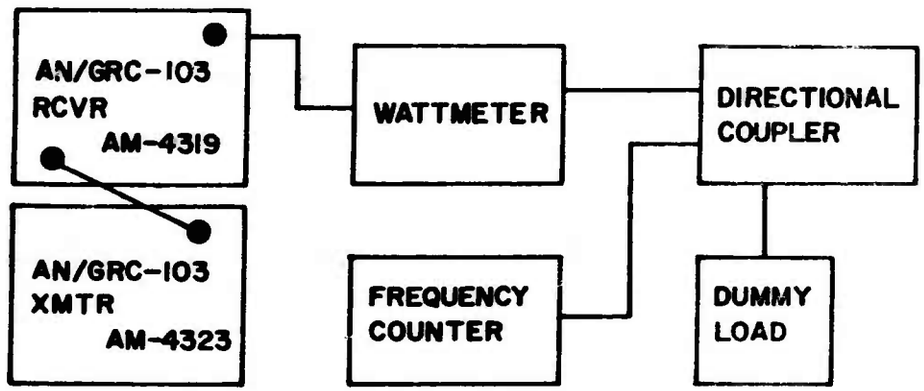


Figure 18. Test setup for duplexer tuning.

TABLE VIII. DUPLEXER TUNING TEST RESULTS

Channel	XMTR PWR Out Watts	% XMTR PWR Out	% Ref PWR XMIT	XMIT Dup % PWR	Rec % Ref PWR	Freq (MHz)
2300	19.5	85	4	75	10	1350
2315	19	80	9	74	10	1357
2330	19	80	7	73	9	1365
2345	17	77	1	70	5	1372
2360	16	73	0	70	5	1380
2375	14.5	68	1	68	8	1387
2390	17	77	0	72	9	1395
2405	19	82	3	80	7	1402
2420	17	82	3	79	7	1410
2435	14.8	80	1	76	10	1417
2450	15	85	0	80	15	1425
2465	14	85	0	81	17	1435
2480	14	87	0	82	11	1440
2495	13	88	0	80	7	1447
2510	12	89	2	80	8	1455
2525	12	88	1	80	11	1462
2540	11.5	85	3	80	13	1470
2555	11	80	7	80	10	1477
2570	9.5	75	7	71	8	1485
2585	9.5	70	6	70	10	1492
2600	11	78	10	79	15	1500
2615	11.5	81	10	80	18	1507
2630	11.3	80	4	79	12	1515
2645	12	81	3	80	8	1522
2660	12	86	0	79	10	1530
2675	12	87	6	80	16	1537
2690	11.5	84	3	80	19	1545
2705	12	83	0	80	15	1552
2720	12	84	0	79	9	1560
2735	17.5	86	2	78	7	1567
2750	12	87	0	80	11	1575
2765	12	83	0	80	15	1582
2780	11.5	81	0	79	12	1590
2795	10.2	80	0	70	9	1597
2810	12.8	83	6	80	10	1605
2825	11	80	1	75	16	1612
2840	11.5	80	12	79	20	1620
2855	13	89	11	80	16	1627
2820	13	90	0	79	9	1635
2885	14.5	91	5	80	3	1642

TABLE VIII. DUPLEXER TUNING TEST RESULTS (CONT)

Channel	XMTR PWR Out Watts	% XMTR PWR Out	% Ref PWR XMIT	XMIT Dup % PWR	Rec % Ref PWR	Freq (MHz)
2900	13.5	93	10	80	10	1650
2915	12.5	90	1	79	16	1657
2930	14	91	0	80	16	1665
2945	13.5	93	0	80	12	1672
2960	13	90	0	79	12	1680
2975	13	90	3	80	19	1687
2990	13	91	0	80	20	1695
3005	11	91	3	72	15	1702
3020	11	91	5	70	7	1710
3085	11.5	90	0	71	2	1717
3050	12	93	3	69	11	1725
3065	12	92	2	80	19	1732
3080	12	90	6	72	9	1740
3095	11.7	90	3	71	9	1747
3110	12	88	10	73	10	1755
3125	11.5	85	10	71	9	1762
3140	10	79	14	69	4	1770
3155	9	77	11	65	8	1777
3170	90	90	9	76	16	1785
3185	12	90	0	80	21	1792
3200	12	90	0	80	20	1800
3215	12	90	3	75	15	1807
3230	11	90	10	70	8	1815
3245	11.5	80	6	71	6	1822
3260	12	82	10	75	10	1830
3275	11.7	80	12	75	11	1837
3290	11	79	20	70	10	1845

2.32 SYSTEM LEVEL STABILITY

2.32.1 Objective

The objective of this subtest was to determine the radio system level stability.

2.32.2 Criteria (EL-CP0150-0001A, para 3.15)

The system gain shall not vary more than ±1.0 dB in any 8-hour period between the transmitter video input and the receiver video output terminals when the received signal is varied between -95 and -45 dBm.

2.32.3 Data Acquisition Procedure

a. The test setup is shown in figure 19.

b. The system operating frequency was 1645.5 MHz (channel 2891).

c. A 10 kHz signal with an amplitude value of 0.354 volts was applied to the transmitter video input, and the input level control adjusted to provide transmitter deviation of ±180 kHz, as was observed on the deviation meter.

d. The receiver RF signal input level was adjusted with the variable attenuator to provide receiver video output quieting of -65 dBm. The attenuation required to arrive at this video output level was recorded.

e. Without changing the signal level adjustments prescribed in paragraph c and d above, the input line voltage was varied between 105 and 125 Vac during a subsequent 8-hour period. Variations in receiver video output during this test were recorded.

f. The RF input attenuation to the receiver was increased to produce a video output reading of -30 dBm. The input line voltage test was repeated for another 8-hour period.

2.32.4 Results

The data is voluminous and can be provided upon request, however, the system gain varied .9 dB during the test duration.

2.32.5 Analysis

The system gain did not vary more than ±1.0 dB. The test item met the criteria.

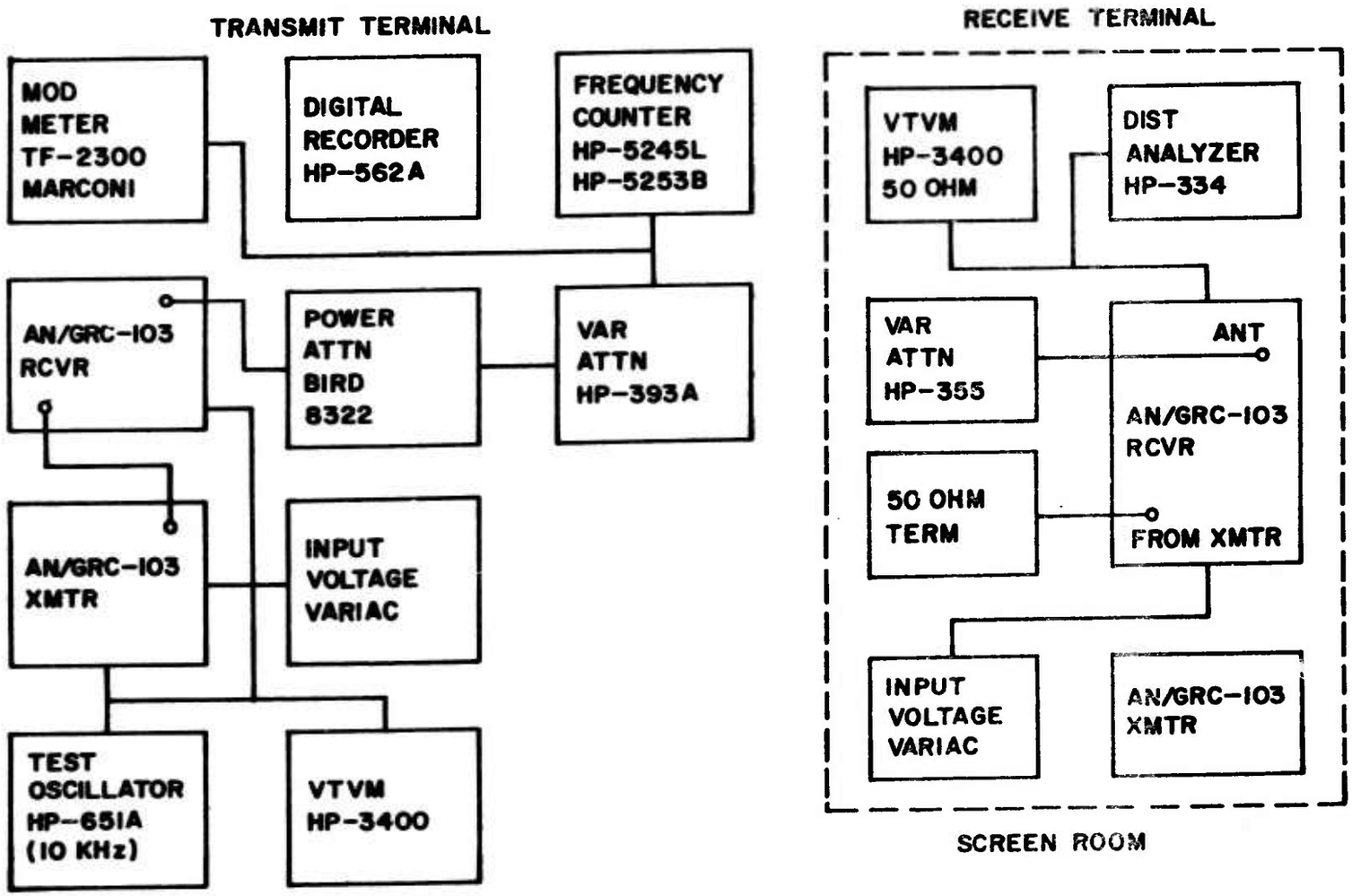


Figure 19. Test setup for system level stability.

2.33 SPURIOUS RESPONSE

Combined with subtest 2.36.

2.34 SPURIOUS OUTPUTS

Combined with subtest 2.36.

2.35 MUTUAL INTERFERENCE

2.35.1 Objective

The objective of the subtest was to determine the degree of mutual interference exhibited by the radio set.

2.35.2 Criteria (EL-CP0150-0001A, para 3.15.1)

A transmitter shall be tuned to any channel in its operating band and coupled to an antenna through the duplexer. With the receiver connected to the same antenna through the duplexer, there shall be a maximum of eight channels unusable by the receiver, exclusive of the channels in a ±20 MHz band centered around the transmitter frequency. An unusable channel shall be defined as a channel on which the receiver cannot receive a remote signal level of -94 dBm, paragraph 3.13.9 (Signal-to-Noise) of the specification.

2.35.3 Data Acquisition Procedure

a. The test configuration is shown in figure 20.

b. The transmitter (SN 009) was tuned to a test channel and its power output was optimized. The transmitter video input level was adjusted for 12 channel operation.

c. Utilizing the signal generator as the remote signal source, the receiver and signal generator were tuned to the same frequency while covering all channels exclusive to those within 20 MHz above and below the transmitted channel. The receiver RF input level was maintained at -94 dBm at each receiver frequency. An unusable channel was defined as one where the signal power-to-noise power at the video output of the receiver was less than 12 dB (which is shown in paragraph 3.13.9 of the specification).

d. The above procedure was performed at transmit test channels 2360, 2570, 2785, 2990, and 3245.

2.35.4 Results

The data is voluminous and can be provided upon request, however, there wre eight unusable channels outisde the ±40 channel (±20 MHz) bandcentered around each test frequency.

2.35.5 Analysis

The criteria was met.

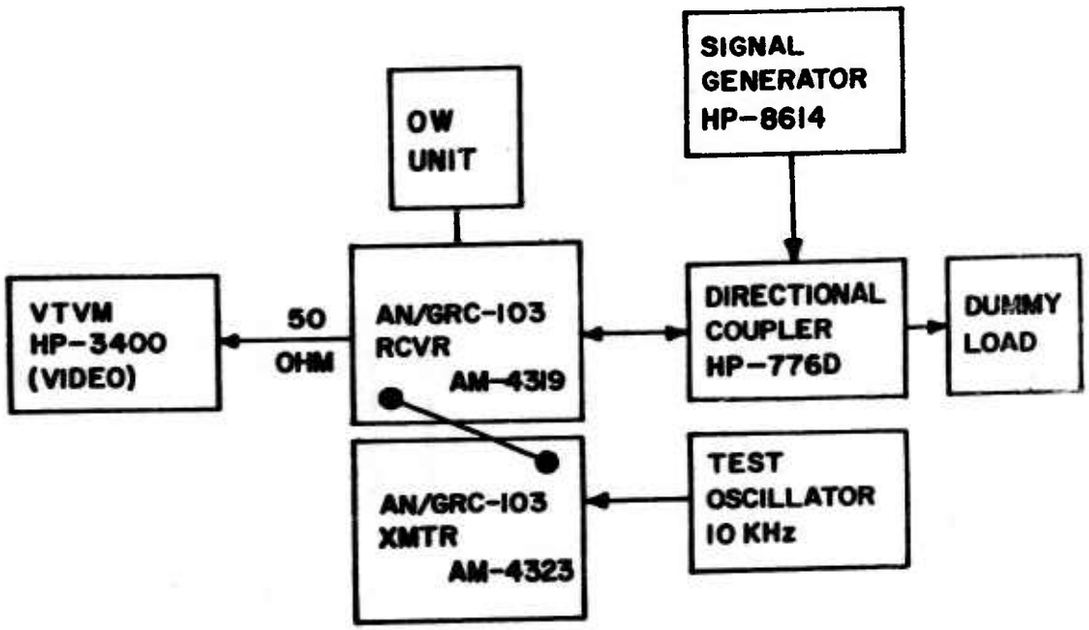


Figure 20. Test setup for mutual interference.

2.36 ELECTROMAGNETIC INTERFERENCE

2.36.1 Objective

The objective of this subtest was to determine if the test item meets electromagnetic interference requirements.

2.36.2 Criterion (EL-CP0150-0001A, para 3.25).

The test item shall meet the emission and susceptibility requirements of MIL-STD-461A, Notice 4, Table A-1 as follows: CE04, CE06. CS01, CS02, CS04, CS06, RE02, RE02.1, and RS03.2.

2.36.3 Data Acquisition Procedure

a. The test item was set up in a shielded room and was operated with 115 V/60 Hz power in a loop back configuration using multiplexer set AN/TD-660 as the signal source. The primary operating frequency was 1800 MHz. Susceptibility was defined as any data change sufficient to activate the TD-660 data alarm.

b. Conducted emission, power leads, 150 kHz to 65 MHz (CE04). The test item was set up as shown in figure 1. Emissions were measured on each power lead with the test item operating in loop back mode.

c. Conducted emission, antenna terminal, 14 kHz to 12.4 GHz (CE06). The test item was set up as shown in figure 2. Emissions were measured in key-up mode and key-down mode, with reject filter adjusted to attenuate the operating frequency (1.8 GHz).

d. Conducted susceptibility, power leads, 30 Hz to 15.0 kHz (CS01). Continuous-wave voltages at 3.0 Vrms were impressed on the power leads as shown in figure 3. The TD-660 alarm was monitored for indication of data errors.

e. Conducted susceptibility, power leads, 150 kHz to 65 MHz (CS02). Voltages at 0.1 Vrms and 90 dB μV/MHz were impressed on the power leads as shown in figure 4. The TD-660 alarm was monitored for indication of data errors.

f. Conducted susceptibility, rejection of undesired signals, 30 Hz to 10 GHz, (CS04). The test item was set up as shown in figure 5, with one signal generator output applied to the receiver terminal. The signal generator was tuned to the receiver f_o, output was reduced to a point of marginal signal for receiver signal hold-in. The signal generator output was then increased by 100 dB and swept from 200 MHz to 18 GHz.

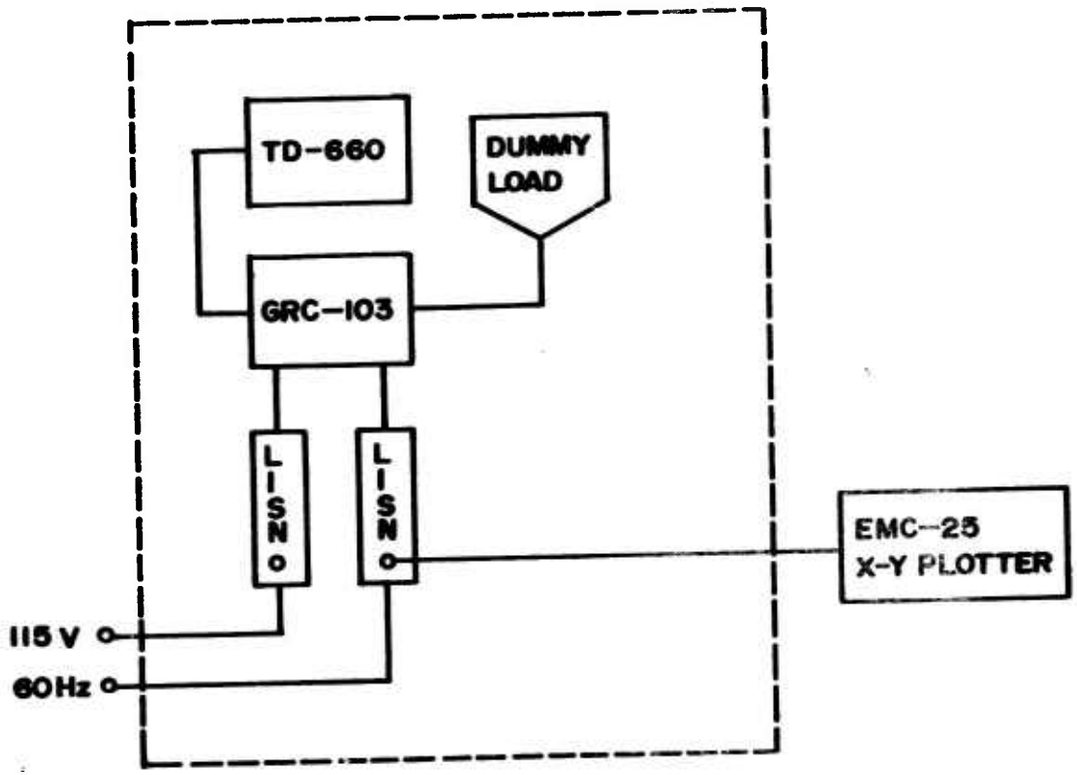


Figure 21. Conducted emission, power leads, 150 kHz to 65 MHz (CE04) test setup.

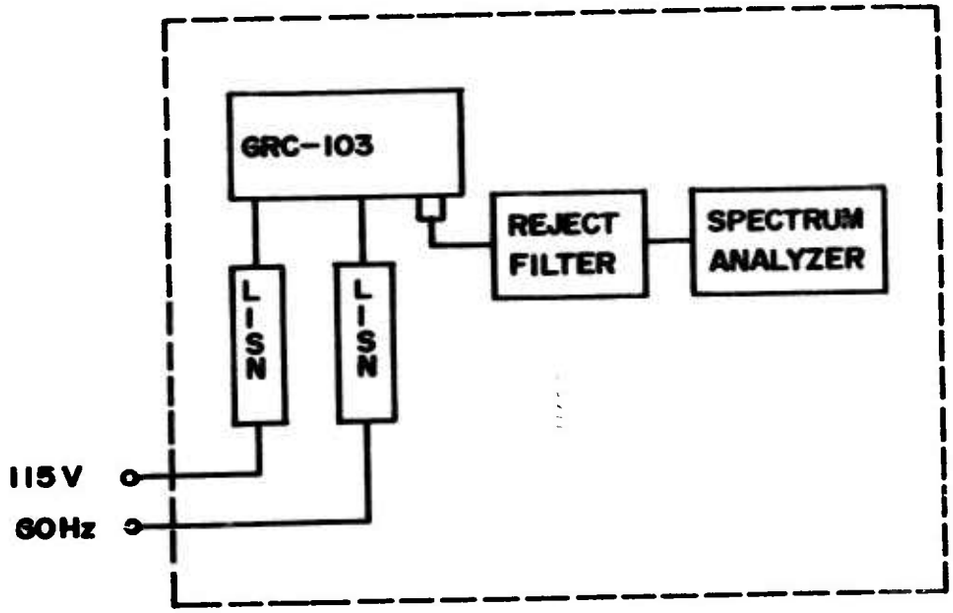


Figure 22. Conducted emission, antenna terminal, 14 kHz to 12.4 GHz (CE06) test setup.

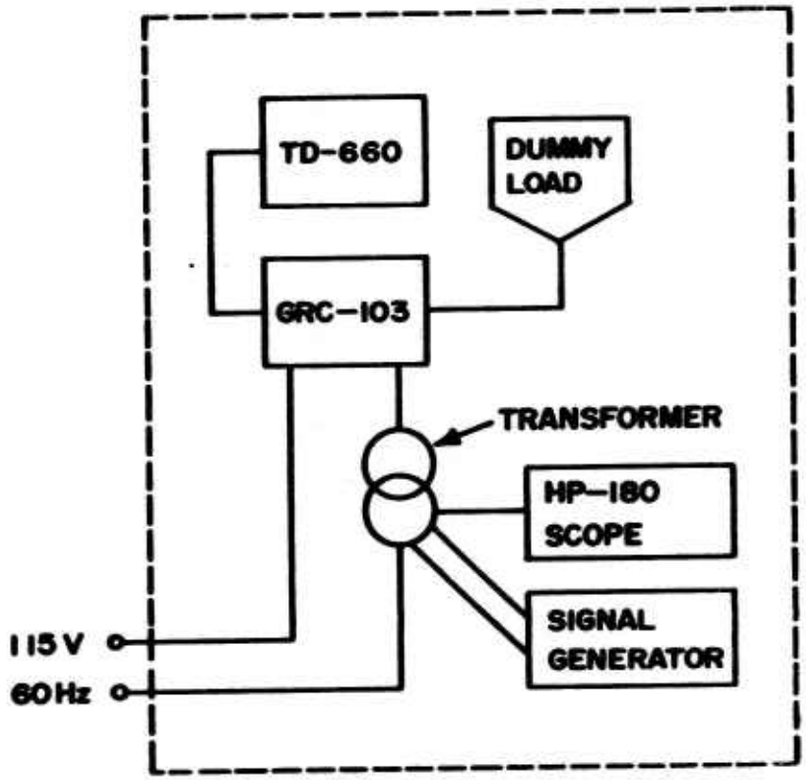


Figure 23. Conducted susceptibility, power leads, 30 Hz to 15.0 kHz (CS01).

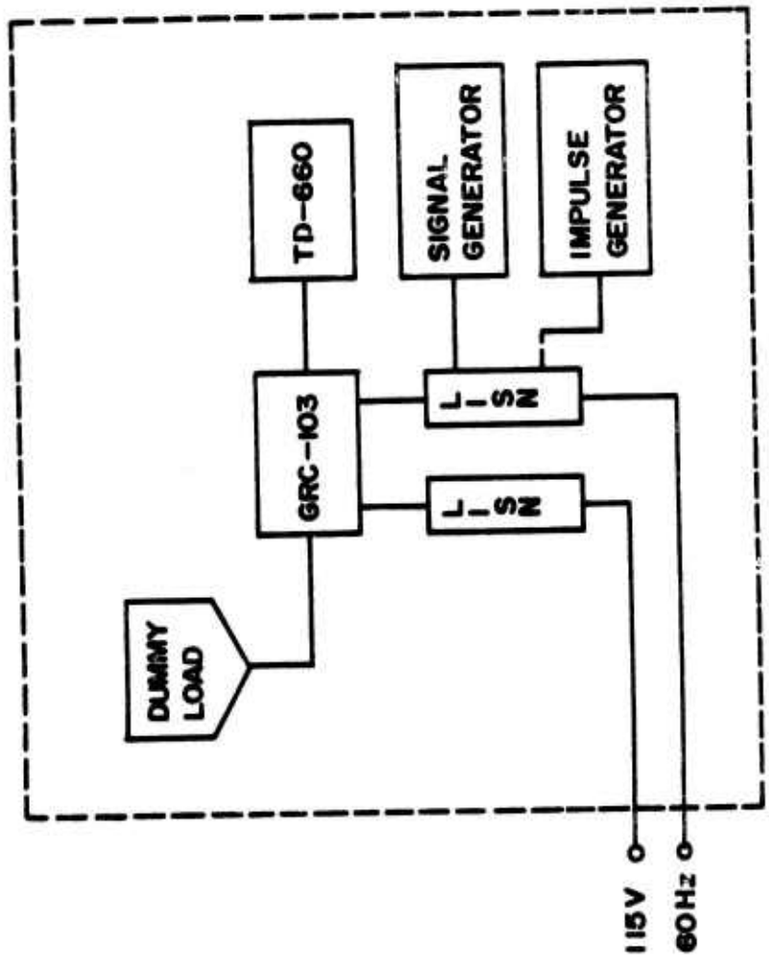


Figure 24. Conducted susceptibility, power leads, 150 kHz to 65 MHz (CS02).

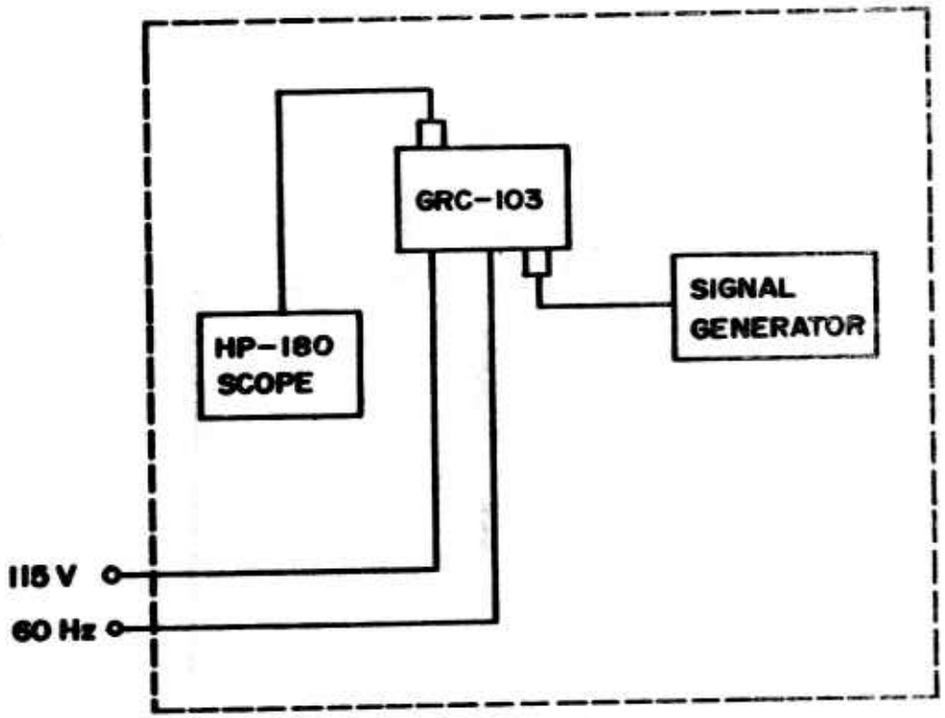


Figure 25. Conducted susceptibility, rejection of undesired signals, 30 Hz to 10 GHz (CS04) test setup.

g. Conducted susceptibility, power leads, spike, (CS06). Spike voltage at 100 V peak was impressed on the power leads as shown in figure 26. The TD-660 alarm was monitored for indication of data errors.

h. Radiated emission, electric field broadband, 14 kHz to 1.0 GHz (RE02). The test item was set up as shown in figure 27. Emissions were measured from 14 kHz to 1 GHz.

i. Radiated emission, electric field narrowband, 14 kHz to 12.4 GHz (RE02.1). The test item was set up as shown in figure 27. Emissions were measured from 14 kHz to 12.4 GHz.

j. Radiated susceptibility, electric field, 14 kHz to 12.4 GHz (RS03.2). The test item was set up as shown in figure 28. Electric fields were generated as specified; the TD-660 alarm was monitored for indication of data errors.

2.36.4 Results

a. Conducted emission, power leads, 150 kHz to 65 MHz (CE04). Emissions were at least 10 dB below limits.

b. Conducted emission, antenna terminal, 14 kHz to 12.4 GHz (CE06). Emissions were at or below the 34 dBμV limit (key-up). Emissions were at least 20 dB below the limits for key-down operation.

c. Conducted susceptibility, power leads, 30 Hz to 15 kHz (CS01). No susceptibility conditions were noted during the test.

d. Conducted susceptibility, power leads, 150 kHz to 65 MHz (CS02). No susceptibility conditions were noted during the test.

e. Conducted susceptibility, rejection of undesired signals, 30 Hz to 10 GHz (CS04). Undesired signal rejection was over 100 dB from 50 MHz to 10 GHz.

f. Conducted susceptibility, power leads, spike (CS06). No susceptibility conditions were noted during the test.

g. Radiated emission, electric field broadband, 14 kHz to 1 GHz (RE02). Broadband emissions were above limits from 14 kHz to 60 kHz, with maximum emission 20 dB above the limit at 20 kHz.

h. Radiated emission, electric field narrowband, 14 kHz to 12.4 GHz (RE02.1). Narrowband emissions were equal to the limit at 3.6 GHz (2nd harmonic of f_o). Other narrowband emissions were at least 6 dB below the limits.

i. Radiated susceptibility, electric field, 14 kHz to 12.4 GHz (RS03.2). No susceptibility conditions were noted during the test.

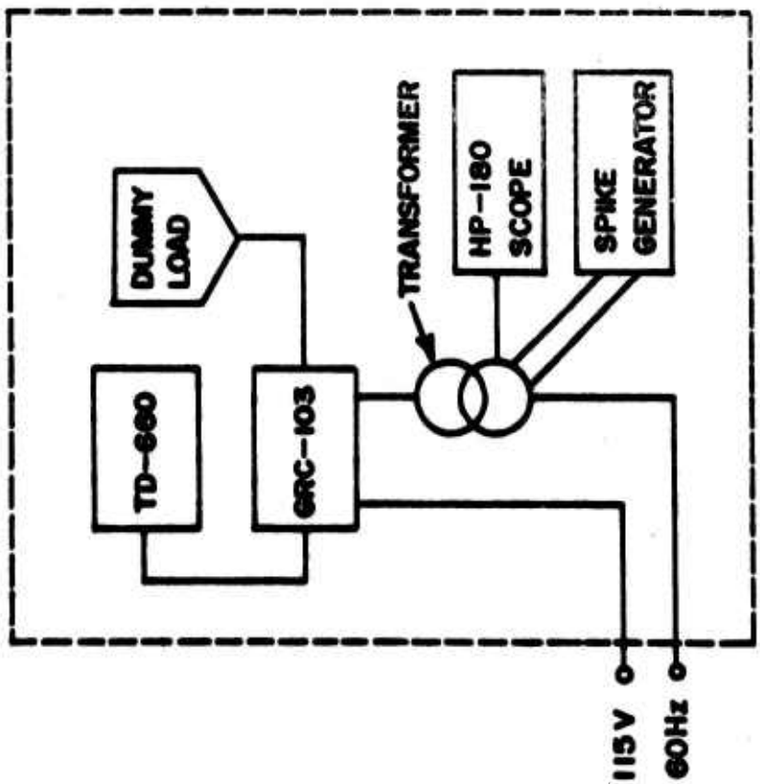


Figure 26. Conducted susceptibility, power leads, spike (CS06).

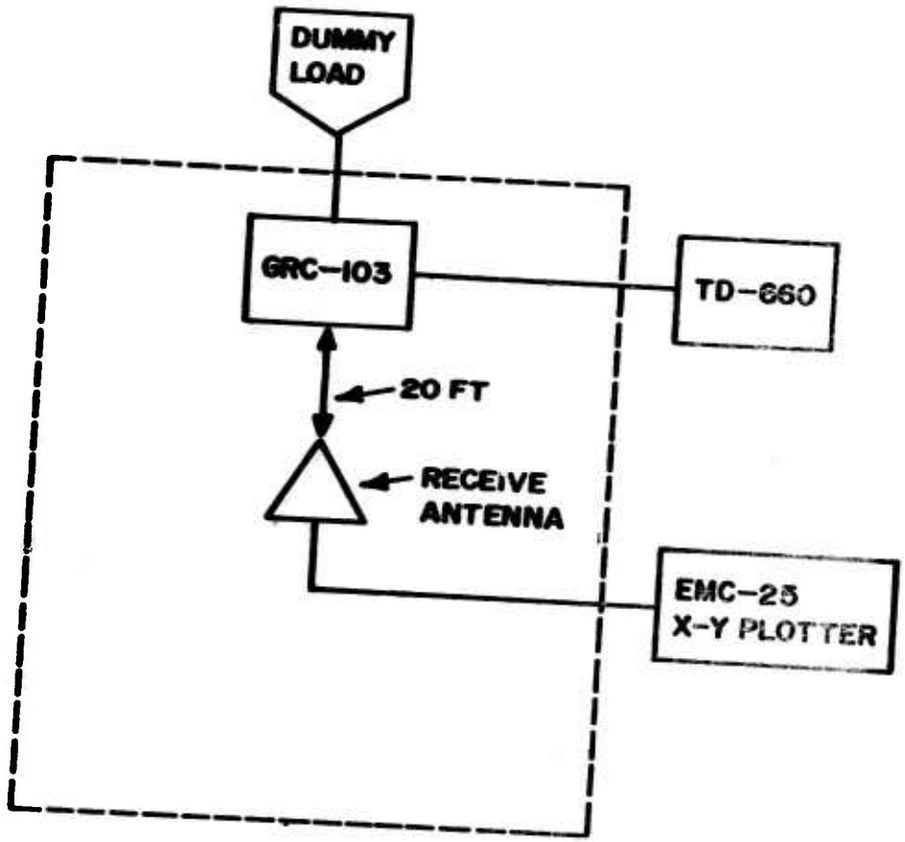


Figure 27. Radiated emission, electric field broadband, 14 kHz to 1.0 GHz (RE02) test setup.

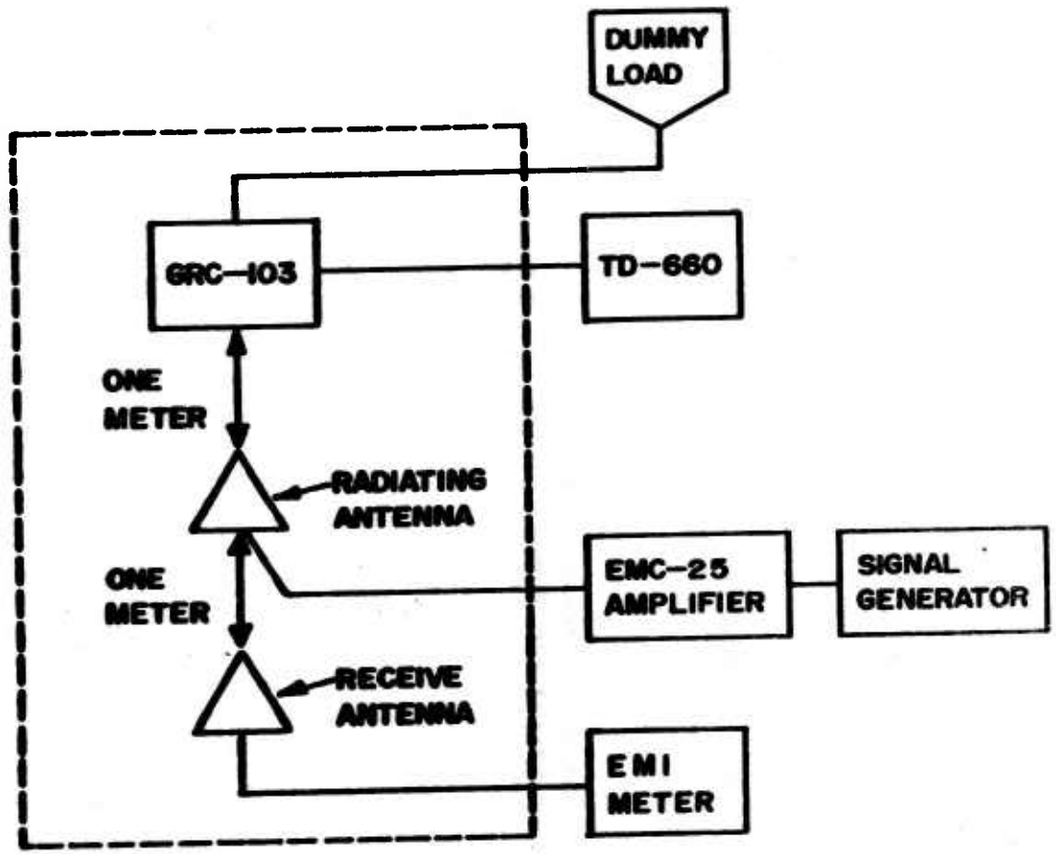


Figure 28. Radiated susceptibility, electric field, 14 kHz to 12.4 GHz (RS03.2) test setup.

2.36.5 Analysis

The test item met requirements for methods CE02, CE06, CS01, CS02, CS04, CS06, RE02.1, and RS03.2. The test item did not meet requirements for mathod RE02. Broadband emissions at 60 kHz and below are not considerad to ba a threat to communications. The tast item is considered as acceptabla.

2.37 LOW TEMPERATURE

2.37.1 Objective

The objective of this subtest was to determine if the radio set can withstand a low temperature environment.

2.37.2 Criteria (EL-CPO150-0001A, paras 3.21.1.1 and 4.10.1.1)

The test item shall not exhibit any physical damage or degradation of performance following storage at -65°F (-54.3°C) and operation at -35°F (-37.2°C).

2.37.3 Data Acquisition Procedure

The AN/GRC-103 Band IV components were subjected to the test of Method 502, Procedure I of MIL-STD-810B.

2.37.4 Results

The test items (SN 006) suffered no damage or degradation in specified performance as a result of the test.

2.37.5 Analysis

Low temperature had no physical damage or degradation in performance adversely affecting the AN/GRC-103 Band IV components following storage at 155°F and operation at 125°F.

2.38 HIGH TEMPERATURE

2.38.1 Objective

The objective of this subtest was to determine if the radio set can withstand a high temperature environment.

2.38.2 Criteria (EL-CPO150-0001A, paras 3.21.1.2 and 4.10.1.2)

The test item shall exhibit no physical damage or degradation in performance following storage at 155°F (68.9°C) and operation at 125°F (51.6°C).

2.38.3 Data Acquisition Procedure

The test was set up during the period 31 August through 2 September 1976, the Band IV components of the AN/GRC-103 were subjected to the test of Method 301, Procedure II of MIL-STD-801B.

2.38.4 Results

The test items (SN 006) suffered no damage or degradation in specified performance.

2.38.5 Analysis

High temperature had no physical damage or degradation in the performance of the AN/GRC-103 Band IV components following storage at 155°F and operation at 125°F.

2.39 HUMIDITY

2.39.1 Objective

The objective of this subtest was to determine if the radio set can withstand a high humidity environment.

2.39.2 Criteria (EL-CP0150-0001A, paras 3.21.2 and 4.10.2)

The test items shall exhibit no physical damage or deterioration in operational performance when subjected to a high humidity environment.

2.39.3 Data Acquisition Procedure

The Band IV components of the AN/GRC-103(V) were tested in accordance with MIL-STD-810B, Method 507, Procedure II. The test was performed at the Climatic Test Section (ECOM), Fort Monmouth, New Jersey. Two different sets of components were tested. During humidity cycling, performance tests were conducted every 24 hours.

2.39.4 Results

a. The Frequency-Multiplier AM-4323/GRC-103(V) of set A (SN 90073A0007) was declared a failure due to the absence of multiplier output. The failed unit was replaced by SN 90073A0009, which had been modified by Canadian Marconi. This unit experienced slight corrosion and showed no degradation in performance during the test.

b. At the end of the humidity test, the Frequency-Multiplier AM-4323/GRC-103(V) of set B (SN 90073A0008) was declared a failure due to the absence of multiplier and power output. The problem in this unit as well as the unit in set A was determined to be the multiplier module. The Amplifier-Converter AM-4319/GRC-103(V) of both units operated as specified and experienced slight corrosion during the test.

2.39.5 Analysis

The unmodified Frequency-Multiplier AM-4323/GRC-103(V) cannot withstand the effects of high humidity. It appears that high humidity will adversely affect the multiplier module. This is classified as a deficiency. The Amplifier-Converter AM-4319/GRC-103(V) will operate as specified when subjected to high humidity. The corrosion effects of humidity on both components appears to be insignificant.

2.40 ALTITUDE

2.40.1 Objective

The objective of this subtest was to determine if the radio set can withstand a high altitude environment.

2.40.2 Criteria (EL-CP0150-0001A, paras 3.21.3 and 4.10.3)

a. The equipment shall meet full specification performance during and after testing as specified in paragraph 4.10.3.

b. The equipment shall be tested in accordance with Method 500, Procedure I, of MIL-STD-810B. The chamber may be returned to ambient atmospheric pressure for frequency changes.

2.40.3 Data Acquisition Procedure

The AN/GRC-103 Band IV components were subjected to the test of Method 500, Procedure I, of MIL-STD-810B on 31 August 1976. The non-operating altitude was 17,500 feet (Reference: TECOM letter, AMSTE-ME dated 1 Aug 73, subject: Altitude and Temperature Altitude Tests of Ground Equipment).

2.40.4 Results

The test items (SN 006) suffered no damage or degradation in specified performance.

2.40.5 Analysis

High altitudes caused no damage or degradation in the performance of the AN/GRC-103 Band IV components.

2.41 BENCH HANDLING

2.41.1 Objective

The objective of this subtest was to determine if the test item can withstand normal bench handling shocks.

2.41.2 Criteria (EL-CP0150-0001A, paras 3.21.4 and 4.10.4.3)

The equipment shall be tested in accordance with Method 516.1, Procedure V, of MIL-STD-810B. Prior to and after testing, the equipment shall meet full specification performance.

2.41.3 Data Acquisition Procedure

The Band IV components of the AN/GRC-103 were subjected to the test of Method 516.1, Procedure V of MIL-STD-810B.

2.42.4 Results

The test item (SN 009) suffered no damage or degradation in specified performance.

2.42.5 Analysis

The AN/GRC-103 Band IV components suffered no damage or degradation in performance when subjected to the shock incurred during service and handling.

2.42 VIBRATION

2.42.1 Objective

The objective of this subtest is to determine if the test item can withstand vibrations encountered during transportation.

2.42.2 Criteria (EL-CP0150-0001A, paras 3.21.4 and 4.10.4.1)

a. The equipment shall be tested in accordance with MIL-STD-810B, Method 514, Procedure IV, Part 1. Prior to and after testing the equipment shall meet full specification performance.

b. The test item shall be subjected to sinusoidal vibration in its three mutually perpendicular axes, consisting of logarithmic cycling from 5 to 500 to 5 Hz. The sweep rate shall be 5 to 500 to 5 Hz in 15 minutes. Vibratory inputs to the test item shall be 1 inch double amplitude constant displacement from 5 to 5.5 Hz, 1.5 G's peak constant acceleration from 5.5 to 30 Hz, 0.033 inch double amplitude constant displacement from 30 to 50 Hz, and 1.5 G's peak constant acceleration from 50 to 200 Hz. Total test times shall be 300 minutes per axis of vibration. Operational tests shall be performed after each axis of operation.

2.42.3 Data Acquisition Procedure

During the period 29 Nov - 8 Dec 76, the AN/GRC-103(V) Band IV components were tested in accordance with MIL-STD-810C, Method 514.2, Procedure VIII, Curve V. Operational performance tests were performed after each axis of vibration.

2.42.4 Results

The operational test performed on the AM-4323/GRC-103(V) after vibration in the Z-axis showed no multiplier, driver, or power output. An internal inspection of the test item (SN 90073A0011) showed the defective part to be the Frequency-Multiplier module, Part No. 40A2. The AM-4319/GRC-103(V) (SN 90073A0008) met all operational requirements after the test.

2.42.5 Analysis

While the AM-4319/GRC-103(V) appears capable of withstanding the effects of vibration induced during transportation as part of a vehicular assemblage, the AM-4323/GRC-103(V) does not appear to be capable of withstanding the effects of such an environment.

2.43 ANTENNA PERFORMANCE

2.43.1 Objective

The objective of this subtest was to determine the performance characteristics of the band IV antenna.

2.43.2 Criteria (EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7)

a. The ratio of the half-power (-3 dB) E- and H-plane beamwidth shall not exceed 2.0:1 over the frequency range.

b. The gain of the antenna measured in the direction of the normal from the antenna shall not differ from the maximum gain measured at any frequency in the operating range by more than 0.5 dB.

c. The ratio of major lobe of the antennas to any minor lobe shall be at least 20 dB at any frequency in the operating range.

d. The gain of the antenna shall be at least 18 dB at 1350 MHz and 20 dB at 1850 MHz relative to an isotropic radiator.

e. The VSWR measured at the antenna terminals shall not exceed 1.75:1 over the operating frequency range.

f. The nominal impedance of the antenna shall be 50.0 ohms.

2.43.3 Data Acquisition Procedure

a. The test setups are shown in figures 29 and 30.

b. The test was conducted utilizing a portion of the USAEPG Antenna Evaluation Test Range. The tower and platform are made of non-metalic material. Reflective surfaces were covered with RF absorbent material. It was noted that the range between the antennas was 500 feet. This exceeds the requirement of $R = \frac{4D^2}{\lambda}$. The height is 35 feet which exceeds the requirement of $H = 4D$.

c. The following test equipment was utilized:

1. Polar Recorder SA 1530
2. Rectangular Recorder SA 1520
3. Microwave Receiver SA 1710
4. Standard Gain Horn Antenna SA Series 12
5. Crystal Mixers SA Series 13A & 14
6. Signal Source HUGHES
7. Position Indicator Units SA Series 4400
8. VSWR Meter & Slotted Line

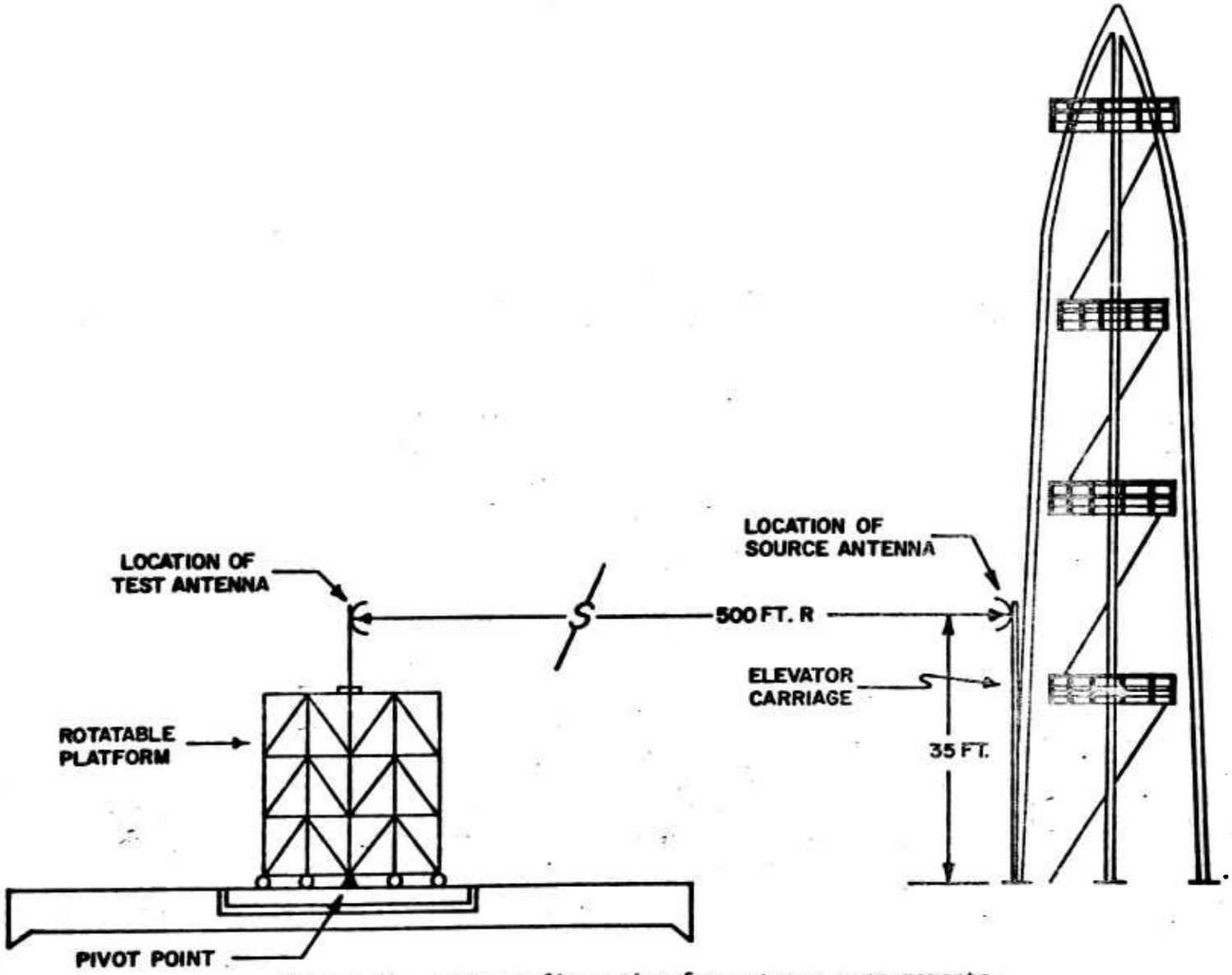


Figure 29. Test configuration for antenna measurements.

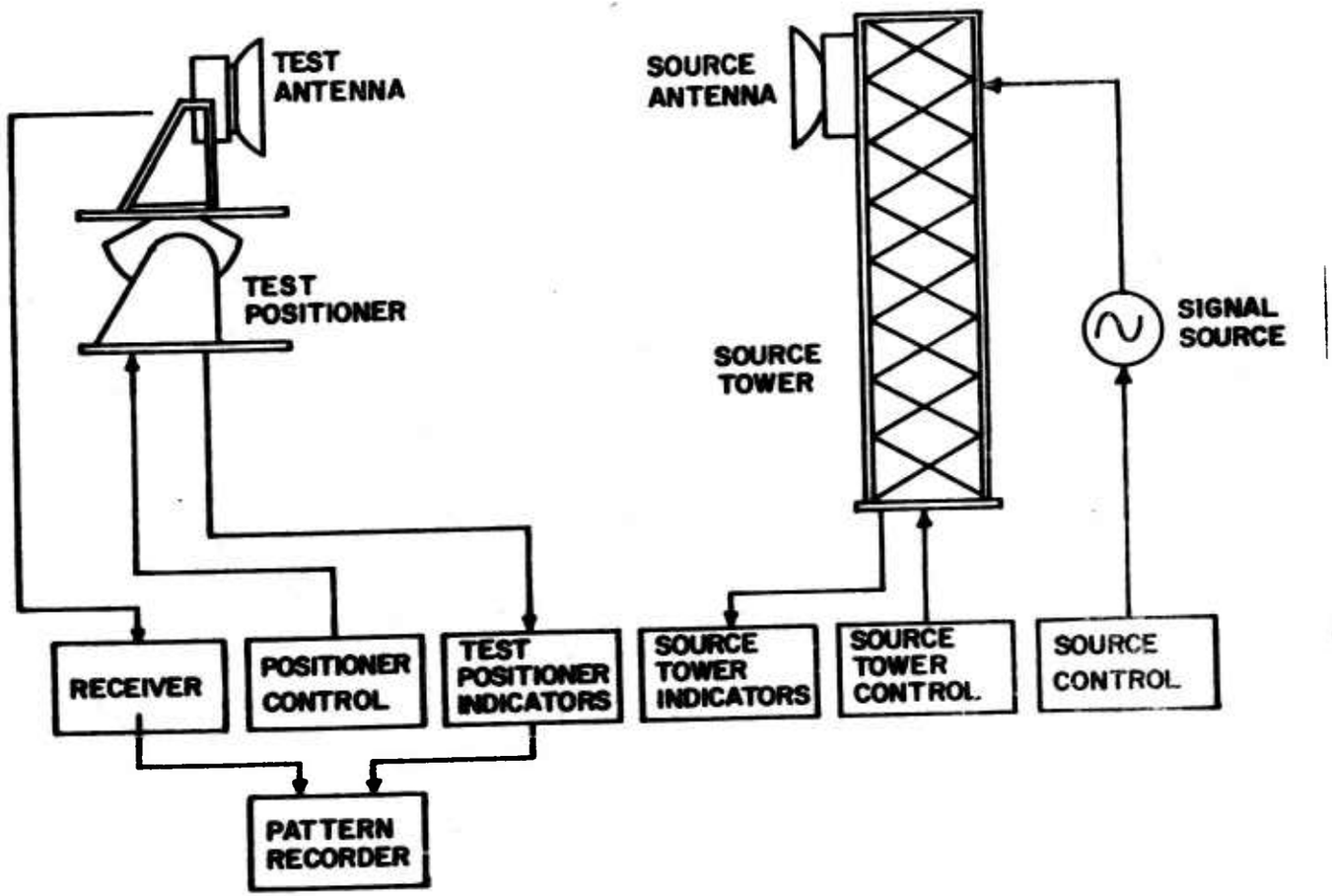


Figure 30. Antenna measurements.

d. The above equipment was interconnected as shown in figure 23. The symmetry, vertical and horizontal cuts were recorded. The half-power points on both planes were determined and their ratio recorded.

e. The squint angle of the test item antenna was determined by boresighting it on the test source antenna. The test antenna was rotated from boresight to the point of maximum signal strength. The signal levels at both maximum signal strength points were recorded. The squint angle was thus determined.

f. The antenna patterns taken as in paragraph d above were analyzed to determine side-lobe suppression.

g. For antenna gain, the standard gain horn was substituted for the test antenna on each measurement of maximum signal. The levels received by the test antenna were compared to those received by the standard gain horn to determine the test antenna gain.

h. Standard techniques were used in determining the antenna VSWR and impedance characteristics.

i. All measurements were repeated at 5, 50, and 95 percent of the bandwidth for which the antenna was designed. Detailed step-by-step methods are described in Materiel Test Procedure 6-2-020.

2.43.4 Results

a. The ratio of the half-power (-3 dB) E- and H-plane beamwidth is 1.0:1 over the frequency range.

b. The gain of the antenna does not vary more than 0.5 dB over the frequency range, measured in the direction of the major lobe.

c. The ratio of the major lobe to the largest minor lobe is 24 dB.

d. The gain of the antenna is 18 dB at 1350 MHz and 21 dB at 1850 MHz.

e. The VSWR measured at the antenna terminals is 1.25:1.

f. The nominal antenna impedance of the antenna is 50.0 ohms.

2.43.5 Analysis

The criteria were met.

2.44 SYSTEM OPERATION

2.44.1 Objective

The objective of this subtest was to determine the technical performance of the modified AN/TRC-110 and AN/TRC-117 assemblages.

2.44.2 Criteria (Approved Test Plan)

The overall system performance should be at least as good as the unmodified assemblages.

2.44.3 Data Acquisition Procedure

a. The test setup was as shown in figure 31.

b. Initial measurements were taken under simulated field conditions i.e., the RF signal between the assemblages were controlled by electromechanical means.

c. An audio test signal was alternately connected to XMIT channels 3, 5, 7, 9, and 12 on the multiplex equipment in the AN/TRC-117. The test channel receive signal at the multiplex equipment in the AN/TRC-110 was instrumented for signal level and distortion measurements. The test signal was transmitted at 1 kHz, with an amplitude level of -4 dBm. The Order Wire unit was utilized to control the test signal measurements.

d. The above measurements were taken in both directions of communication and at receiver RF signal input levels of -88, -92, -94 and at a PCM threshold level determined from the actual system operation.

e. A field site, with a LOS distance of approximately 32 miles was tested. The AN/TRC-110 assemblage was used as a relay and the AN/TRC-117 was configured as a dual terminal. Traffic was passed in both directions and signal levels and distortion measurements recorded.

f. During the system operation test period a number of antenna erections and dismantling operations were made.

2.44.4 Results

Upon initial testing, four radios suffered an electrical failure, however, this subtest was conducted under the AN/TRC-117/151 product improvement test.

2.44.5 Analysis

The criteria was met.

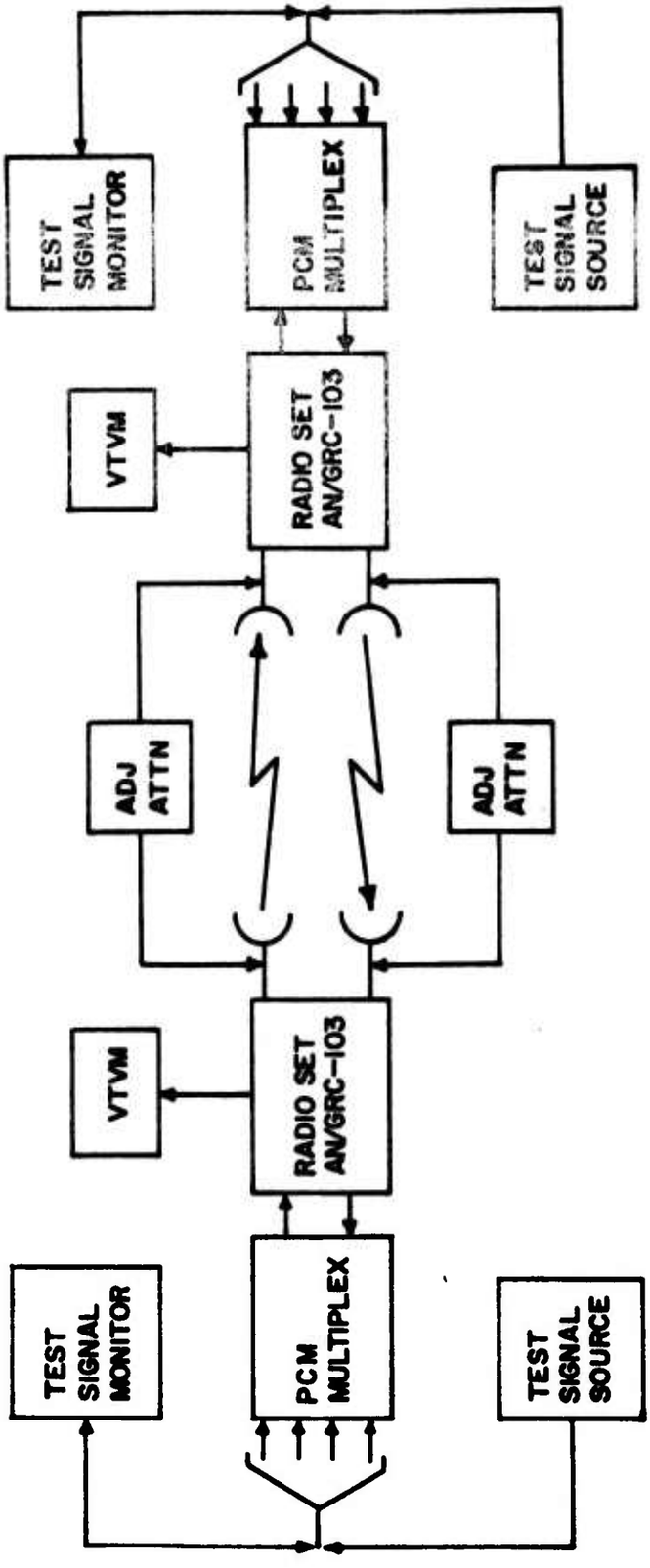


Figure 31. Test setup for system operation.

2.45 HUMAN ENGINEERING

2.45.1 Objective

The objective of this subtest is to determine whether the test item conforms to principles of human factors engineering (HFE).

2.45.2 Criteria

a. Displays of the test item shall present needed information clearly and shall be visible from all reasonable viewing angles (MIL-STD-1472B, para 5.2).

b. Components of the test item that must be located, identified, read, or manipulated shall be appropriately and clearly labeled to permit rapid and accurate human performance. (MIL-STD-1472B, para 5.5)

c. The weight and special precautions in lifting shall be indicated on the compartments of the test item. (MIL-STD-1472B, para 5.9.11.3)

d. Cables shall be labeled to indicate the receptacles with which they mate. The cable plugs shall be designed so that it will be impossible to insert a wrong plug into a receptacle whenever the possibility exists. Connectors shall be spaced far enough apart so they may be grasped firmly for connecting and disconnecting (MIL-STD-1472B, para 5.9.14)

e. The engineering traits of the test item shall be compatible with human limitations and capacities. (MIL-H-46855A, para 3.2)

2.45.3 Data Acquisition Procedure

a. Information on display characteristics were obtained through examination and checklist.

b. Data on labeling were obtained through inspection.

c. Appropriate indication of weight and lift precautions was determined through examination.

d. Characteristics of the cables, cable connectors, and receptacles were obtained through examination and interview.

e. Soldier operator/maintainer personnel performed the assigned tasks associated with set-up, operate, and disassembly of equipment. During execution of these tasks a human factors specialist examined any difficulties encountered of a HFE nature. Additional information or data were obtained through an interview with each test participant and accomplishment of a HFE checklist.

2.45.4 Results

a. Displays presented the equipment status clearly to the operator. When changing frequency the frequency appeared in a window display providing immediate operator feedback.

b. Controls, displays and other objects which must be located, identified, read or manipulated were appropriately and clearly labeled to permit rapid and accurate human performance.

c. The weight was not indicated on the test item.

d. Cables were appropriately labeled. The connectors were keyed so that it will be impossible to insert a wrong plug into a given receptacle. The receptacles were spaced far enough apart that no problem occurred in accessibility to any particular connector.

e. The engineering traits conformed to principles of HFE so that performance demands were compatible with human limitations and capacities.

2.45.5 Analysis

a. Displays were satisfactory from the standpoint of HFE.

b. Labelling of components were satisfactory.

c. The weight indications are essential as they guide the soldier in correct lifting procedure of the test item when installing or removing the test item. (This is a suggested improvement.)

d. The cable characteristics were satisfactory.

e. Other characteristics of the test item were satisfactory from the standpoint of HFE.

2.46 RELIABILITY

2.46.1 Objective

The objective of this subtest was to collect operational data in order to assess the reliability characteristics of the test items.

2.46.2 Criterion (EL-CP0150-0001A, para 3.23.1)

The test items, excluding the GFE, shall have a specified mean-time-between-failure (MTBF) of 3000 hours. These requirements apply when the test items are used in the following manner:

Ambient Temperature - - - - - - - - - 40° ±5°C
Duty Cycle - - - - - - - - - - - - - Continuous operation
Environment - - - - - - - - - - - - - Vehicular ground mounted.

(NOTE: There is no established minimum acceptable value (MAV) MTBF, per AR 702-3, for the test item.)

2.46.3 Data Acquisition Procedure

a. The test setup is shown in figure 32.

b. Three test items (SN 10, 11, 12) were placed in the reliability chamber, as indicated, and operated for a period of 1103 hours (3309 hours total), under the environment of test level B of MIL-STD-781B, with the following modifications:

(1) The vibration was limited to one 8-hour period per week and each test item was vibrated 2 minutes out of each 8 hours.

(2) The test item operating cycle was 71 hours ON, 1 hour OFF. Only "on time" was counted for the 3309 operating-hour duration. During the "off" periods, the RF heads were interchanged between radio sets.

(3) Every 4 hours throughout the test period, the operating channels were changed. Channel changes continued until an accept/reject decision was reached.

c. The following parameters were measured and recorded daily to determine malfunctions and degradation of performance:

(1) Transmitter power output.

(2) Duplexer insertion loss.

(3) Transmitter frequency stability.

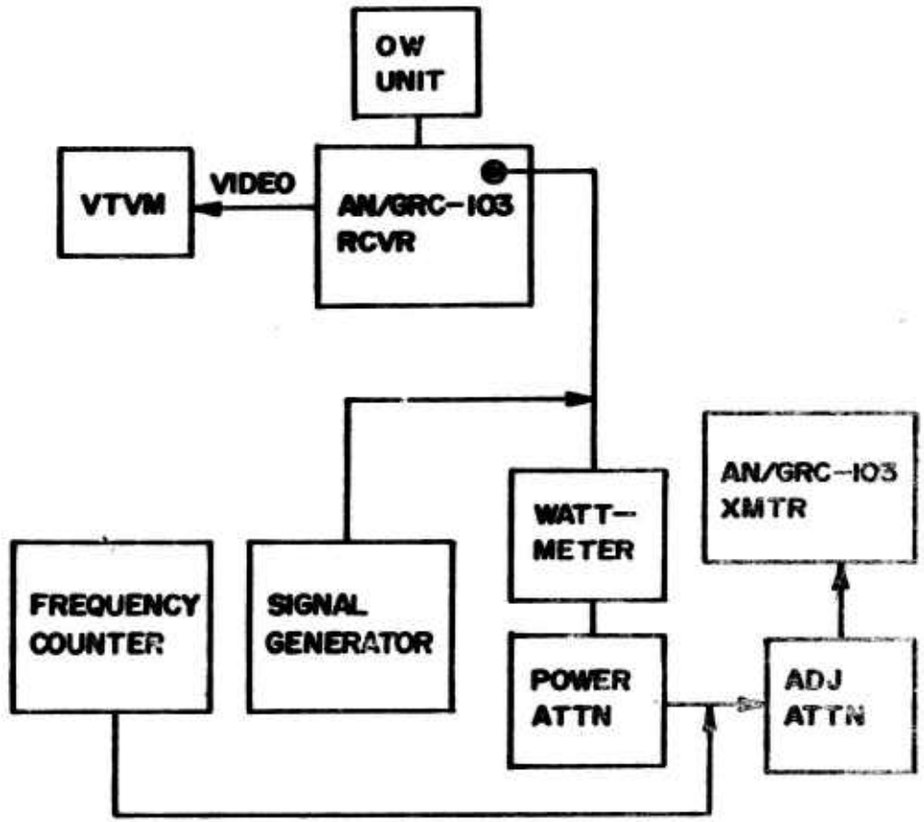


Figure 32. Test setup for reliability.

(4) Receiver sensitivity.

(5) Transmitter and receiver meter readings.

d. Operating hours and malfunctions from other subtests (excluding environmental extremes) were recorded and reported separately. The operating hours on SN 1, 2, 3, 4, and 5 were accumulated during system tests using the AN/TRC-117 and AN/TRC-110.

2.46.4 Results

a. Malfunctions observed during initial inspection are reported in paragraph 2.1.

b. The test items accumulated the following number of operating hours and chargeable failures:

SN	Operating Hours	Chargeable Failures
1	408	1
2	432	1
3	24	1
4	36	1
5	110	0
6	100	0
8	48	0
9	72	0
10	1208	0
11	2031	0
12	1991	1
Total	6460	5

c. The following failures were noted:

(1) The chargeable failures to SN 1, 2, 3, and 4 occurred during the first 48 hours of systems test. The contractor visited the test site and evacuated the test items to the factory. A verbal analysis by telephone revealed that in each case, an integrated circuit (RF amplifier AR2) of the 40A2 frequency multiplier of the AM-4323 had failed.

(2) The power output failed on SN 12 after 126 hours. The failure was isolated to a defective 40A2 frequency multiplier of the AM-4323.

(3) After 1004 hours into the reliability test, SN 12 experienced a failure to the centrifugal fan B1 of transmit case CY-4637( )/GRC-103 (not the test item). SN 12 was placed in another GRC-103 transmit case in an attempt to complete the test. When the power switch was

turned on, a loud crack was heard and there was no power-out. It was discovered that two power transistors had completely melted their leads and a resistor had shattered.

(4) After 150 hours, SN 10 was found to have a defective 40A2 frequency multiplier, defective V1 driver tube, defective V2 output tube, and defective RF amplifier 40AR1 (all of the above are components of the AM-4323 transmitter). The plastic sandwich about the tube cavity of 40AR1 had melted due to excessive heat.

d. See maintenance analysis chart, appendix _ for further details.

2.46.5 Analysis

a. For purposes of computing MTBF, a failure was defined as any malfunction which caused or may cause:

(1) Failure to commence operation, cessation of operation, or degradation of performance below limits specified in EL-CP0150-0001A.

(2) Serious damage to the test item by continued operation.

(3) Serious personnel safety hazards.

b. The primary failure of five 40A2 frequency multipliers and the secondary failure of one additional 40A2 as a result of centrifugal fan failure indicate a definite reliability weakness in the 40A2 Frequency Multiplier. This is a deficiency.

c. Without a detail failure analysis on any of these six failures, it can only be recommended to make a redesign of this module and submit the test items to a retest. It is also recommended to make a design study of the centrifugal fan B1 failures in the CY-4637( ) transmit case. If this is not feasible, then a sensor/switch for the test item should be provided to shut off the test item (and the radio) if excessive heat is generated.

d. The point estimate MTBF achieved during testing was $\frac{6460}{5} = 1292$ hours.

e. Assuming an exponential distribution, it can be stated with 80 percent confidence that the true MTBF of the test item is bracketed by the interval:

$$696 \text{ hours} \leq \text{True MTBF} \leq 2656 \text{ hours}$$

f. The criterion of 3000 hours MTBF was not met due to the high failure rate of the 40A2 frequency multiplier. If the multiplier failures were corrected and assuming that no new failure modes were introduced as a result of the correction, there would be 90 percent confidence that the true MTBF is at least 2805 hours.

g. The failures in 2.46.4c(3) and (4) were a result of centrifugal fan failure which eliminated the required cooling.

2.47 MAINTENANCE EVALUATION

2.47.1 MAINTAINABILITY INDICES

2.47.1.1 Objective. The objective of this subtest was to obtain maintainability data on the test item.

2.47.1.2 Criterion. None.

2.47.1.3 Data Acquisition Procedure

a. Personnel of appropriate military occupational specialty (MOS) 31E were utilized to perform maintenance operations.

b. Personnel performed every organizational maintenance operation specified on the maintenance allocation chart (MAC).

c. Personnel performed direct and general support maintenance operations specified in the MAC as required to support the test system during the test.

d. Simulated maintenance actions were performed and recorded.

e. The adequacy of maintenance instructions, tools, test, measurement, and diagnostic equipment (TMDE), calibration, and handling equipment and repair parts provided with the test item was determined during maintenance operations in paragraphs b, c, and d above.

f. The time required for individual maintenance operation was recorded.

g. A record of all scheduled, unscheduled maintenance and simulated operations to include operating time was maintained throughout the test. Data included a description of all equipment malfunctions for incorrect operation, corrective actions taken, and equipment downtime.

2.47.1.4 Results

a. The test items accumulated the following unscheduled maintenance data:

	Organizational	Direct Support	General Support	Overall
Number of actions	2	4	3	9
Repair time (clock hours)	0.4	2.0	1.1	3.5
Maintenance manhours	0.8	4.0	1.5	6.3

These maintenance actions do not include contractor maintenance performed on-site.

b. Depot maintenance is beyond the scope of Development Test II.

c. Simulated maintenance actions are reported separately and are not included in the maintainability indices computations.

d. See maintenance analysis chart, appendix D for further details.

2.47.1.5 Analysis

a. Based on the accumulated data, the following computations were made:

	Organizational	Direct Support	General Support	Overall
MTTR	$\frac{0.4}{2} = 0.2$ hr	$\frac{2.0}{4} = 0.5$ hr	$\frac{1.1}{3} = 0.37$ hr	$\frac{3.5}{9} = 0.39$ hr
MR	$\frac{0.8}{6460} = 0.0001$	$\frac{4.0}{6460} = 0.0006$	$\frac{1.5}{6460} = 0.0002$	$\frac{6.3}{6460} = 0.001$
Max time to repair (95th percentile)	0.2 hr Based on 2 actions	0.5 hr Based on 4 actions	1.0 hr Based on 3 actions	0.83 hr Based on 9 actions
A_a				$\frac{6460}{6460+3.5} = 0.999$

MTTR = mean time to repair
MR = maintenance ratio
A_a = achieved availability

b. There is no criterion for maintainability indices against which to compare the achieved values.

2.47.2 EQUIPMENT PUBLICATIONS

2.47.2.1 Objective. The objective of this subtest was to determine if the equipment publications provided are suitable for their intended use.

2.47.2.2 Criterion. The equipment publications contained in the maintenance test package shall be complete, accurate, easy-to-read, consistent in nomenclature, simple to follow, and adequate to permit completion of both scheduled and unscheduled maintenance operations and parts acquisition at all field levels of maintenance. Draft Army equipment publications shall conform in content and format to that specified in AR 310-3, MIL-M-38784, and MIL-M-63000 (TM) series of military specifications, as applicable. (AR 702-3, para 2-5)

2.47.2.3 Data Acquisition Procedure

a. Maintenance performed during the test was in accordance with procedures in the manuals.

b. The instructions contained in the test item operating and maintenance manuals were evaluated for simplicity, clarity, consistency, and completeness to determine whether those instructions are commensurate with the training and skill of the operator/crew and maintenance personnel.

c. Block and circuit diagrams and drawings were checked for completeness and accuracy.

d. Troubleshooting instructions and preventive maintenance procedures were checked for completeness and effectiveness.

e. Safety instructions for personnel and equipment were checked for accuracy.

f. Equipment publication data were collected throughout the test and on each maintenance action.

g. Significant equipment publication errors, omissions, and desirable or necessary changes were reported on DA Form 2028.

2.47.2.4 Results

During the test period, the following discrepancies were noted:

a. Draft Technical Manual (DTM) 11-5820-540-12 & P is confusing and incomplete.

(1) The troubleshooting chart indicates that the radio frequency amplifier 40AR1 is replaceable at the organizational maintenance. The DTM states that any unit being held in with screws circled in red are not to be loosened or removed. These screws must be removed to replace the radio frequency amplifier 40AR1. There are no instructions for the removal of the 40AR1 in the DEPTM.

(2) The text of DTM 11-5820-540-12 & P does not follow the functional group sequence as listed in the MAC.

(3) Replacement parts at the organizational maintenance category are not listed in the DEPTM.

b. Draft Equipment Publication (DEP) 11-5820-540-35 is incomplete.

(1) The replacement procedure for the circulator (391HY1) is incomplete. The instructions do not provide for removal of the front panel to gain access to the circulator mounting screws.

(2) There are no removal or replacement procedures for the amplifier, frequency multiplier (40A2), regulator, current (40A2AR1), and regulator voltage subassembly (40A3A1). These items are replaceable at the general support maintenance category. No tools and equipment are specified in the MAC for the replacement of the 40A2 module.

c. Significant equipment publication errors, omissions, and desirable changes were reported on DA Form 2028 to the appropriate activity.

d. A maintenance package literature chart was completed and is included in appendix D.

2.47.2.5 Analysis

The incompleteness of the equipment publications prevents the completion of maintenance functions; therefore, the equipment publications are inadequate. (Deficiency)

2.47.3 REPAIR PARTS

2.47.3.1 Objective. The objective of this subtest was to determine the adequacy, compatibility, and interchangeability requirement for the repair parts furnished.

2.47.3.2 Criterion. Repair parts shall be authorized in adequate quantities and diversity at the appropriate maintenance levels, consistent with the MAC, Repair Parts Special Tools List (RPSTL), and skills required to install and align the parts. Repair parts which are used to maintain the system must be interchangeable with like parts being replaced. (AR 702-3, para 2-5)

2.47.3.3 Data Acquisition Procedure. Throughout conduct of the test, the following observations and considerations were made and necessary data recorded:

a. The repair parts used were compared with like parts being replaced to determine complete interchangeability.

b. All repair parts peculiar to the test item were examined to determine if they can be replaced with standard items already in the logistics system.

c. Repair parts were examined to determine if their design permits easy installation, alignment, and checkout.

d. Checks were made of repair parts initially furnished with the test item and of all repair parts used to determine if all parts can be installed and tested at the intended maintenance category.

e. Repair parts were examined to determine if modular design has been considered.

f. Repair parts used in the test item were compared with the repair parts manual to insure that the data in the manual are adequate to permit the identification/acquisition of the parts by personnel in the field.

2.47.3.4 Results

The replacement of electron tubes V1 and V2 in the AN/GRC-103( ) Band IV transmitter head is designated as an organizational level maintenance function. After such replacement, however, the tuning head requires alignment which is a function of higher level maintenance (Direct Support).

b. A note in DEPTM 11-5820-540-12 & p included a statement "In Band IV, use tubes with part number SM-A-794144. (If standard tube type JAN 7211 is used as a substitute, use tubes manufactured by Machlett Company which are preferred to insure maximum power and proper tuning through the full range.)" The part number for the electron tube in Band IV is not consistent. The note specifies SM-A-794144 and the organizational parts list indicates 242-8000000-000.

c. The following assemblies/subassemblies are replaceable at the organizational level of maintenance as specified by the MAC but are not listed in the organizational parts list:

(1) Amplifier-Converter AM-4319/GRC-103(V).

(2) Control Indicator 39A4.

(3) Amplifier, Frequency Multiplier AM-4323/GRC-103(V).

(4) Control Indicator 40A4.

(5) Amplifier, RF 40AR1.

(6) Antenna AS-3047/GRC-103(V).

d. There were no DS/GS maintenance repair parts and special tools but for the AN/GRC-103(V) Band IV received, consequently, the repair parts for direct support/general support (DS/GS) maintenance were not evaluated.

e. Repair parts in support of the test were not in adequate quantities for the malfunctions experienced. Six malfunctions occurred on the amplifier, frequency multiplier 40A2, and two spares furnished with the test item. The contractor had to be called on several occasions to replenish repair parts to effect repairs.

f. The part number stamped on the top of the electron tubes V1 and V2, and specified for use in the Band IV of the AN/GRC-103( ) in DEPTM 11-5820-540-12 & P is SM-A-794144 (Mfr 80663) with another part number (Marconi) 242-800000 listed below the SM-A number. There is "MACHLETT" marked on the top of the tubes. The preferred substitute specified in the 12 & P manual recommends a JAN 7211 made by Machlett Company. A spare JAN 7211 was in the spare tube compartment with the marking "MACHLETT" on the top of the tube.

2.47.3.5 Analysis

a. The requirement for alignment after the replacement of the tubes V1 and V2 in the Band IV transmitter RF head is beyond the scope of organizational maintenance; therefore, the replacement of tubes should be effected at DS maintenance.

b. The specification of the electron tube JAN 7211 made by Machlett Company as the preferred electron tube over the other JAN 7211 appears to indicate an interchangeability problem whereby other electron tubes would not perform as well as the specified tubes in accordance with the note in DEPTM 11-5820-540-12 & P. The inconsistency of part numbers for the electron tube is confusing. (For information only)

c. The lack of repair parts data for assemblies/subassemblies replaceable at the organizational maintenance category prevents the identification/acquisition of replacement parts by personnel in the field. This item is included as part of the deficiency in the technical manuals.

d The non-receipt of DS/GS repair parts manual precludes the evaluation of repair parts at the DS/GS maintenance category. (For details see subtest 2.1.)

e. There seems to be a duplication of spare parts (tubes), one specified by Marconi manufactured by Machlett and the recommended substitute (Machlett 7211). The performance of the two tubes made by Machlett should be evaluated for significant differences in performance and an attempt should be made to standardize by using the JAN 7211 by Machlett since it is a JAN type.

f. Paragraph b above constitutes a shortcoming.

2.47.4 TOOLS AND TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE)

2.47.4.1 Objective. The objective of this subtest was to evaluate the suitability of the tools and TMDE provided in the maintenance test package.

2.47.4.2 Criterion. The special tools and test equipment outlined in the maintenance literature and/or contained in the maintenance test package shall be necessary and adequate for the performance of all required maintenance tasks at all field levels of maintenance when used in conjunction with the authorized common tools and test equipment contained in the applicable tool kits. Whenever possible, the design of a system should accommodate the use of common tools rather than special tools. Complicated test equipment requiring frequent calibration and restrictive environmental control conditions should be avoided. (AR 702-3, para 2-5)

2.47.4.3 Data Acquisition Procedure. The tools and TMDE specified in the technical manuals and maintenance support plan were utilized. All common and special tools and TMDE supplied with the test system were used at least once throughout the test period in the performance of actual and/or simulated maintenance of the test item.

2.47.4.4 Results

a. Common tools and TMDE used during the test to perform maintenance functions were satisfactory.

b. A 9-inch/pound 5/16-inch open end torque wrench was used in the replacement of modules within the AN/GRC-103 Band IV. This wrench was found to be too bulky in some instances which hampered the use of the wrench. It is needed to complete maintenance operations in accordance with the equipment publications.

c. There is no adequate tool in the specified tool kits TK-101/K, TK-105/G, and TK-100/G to remove the hexagonal nut securing the coax connector of the power monitor (40A1A1) (see fig. 33).

d. Tools and TMDE charts were completed and are included in appendix D.

2.47.4.5 Analysis

Although there was some difficulty in the use of the 9-inch/pound torque wrench and there was no adequate tool to remove the hexagonal nut, all maintenance tasks experienced during the test could be performed at the appropriate maintenance category. The tools and TMDE contained in the equipment publications and MTP list are adequate for their intended use.

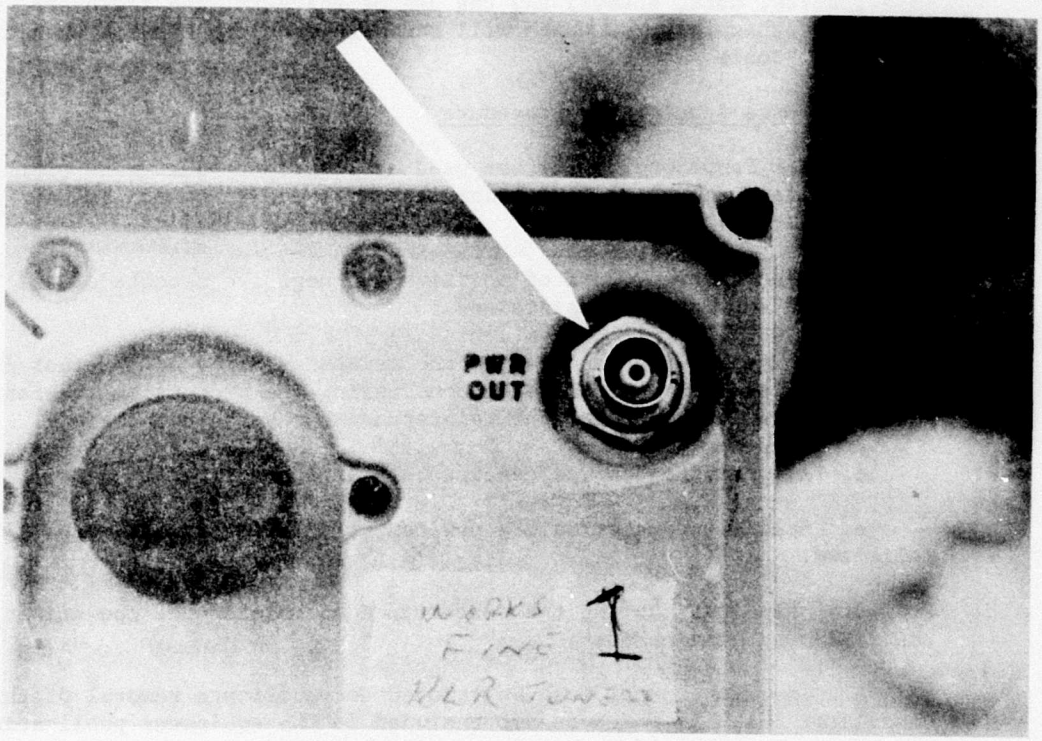


Figure 33. RF connector on the power monitor (40A1A1).

2.47.5 DESIGN FOR MAINTAINABILITY

2.47.5.1 Objective. The objective of this subtest was to determine the adequacy of the design of maintainability of the test item.

2.47.5.2 Criteria. Systems shall be designed to eliminate deficiencies prejudicial to ease of maintenance. System design shall be directed toward minimizing maintenance by using the most reliable components, modular construction, built-in simple fault isolation test indicators, and other technological advances in components and methods to the maximum extent practicable. Means to achieve ease of maintenance include -- (AR 702-3, para 2-5)

a. The location of high mortality parts to provide ready access when maintenance is required.

b. The use of readily accessible test points to reduce diagnostic time.

c. The reduction in number of types and sizes of common fasteners (i.e., bolts, nuts, screws) and the use of quick-release fasteners, wing nuts, and other features which will minimize requirements for special or additional tools.

2.47.5.3 Data Acquisition Procedure

a. AMC Pamphlet 706-134 was used as a guide to determine whether the test item adheres to good maintainability design principles and characteristics.

b. Descriptive record of positive and negative aspects of all maintenance services was maintained.

c. Comments were recorded on the maintainability of the test item under the prevailing environment, considering the protection and conditions expected to exist for the maintenance category in question.

d. All maintenance was continuously evaluated.

e. Soldier-operator/maintainer/tester (SOMTE) comments were solicited.

2.47.5.4 Results. During the performance of maintenance operations, the following were noted:

a. The front panel must be removed to facilitate removal of the circulator 39A1HY1, which is not included in the equipment publications. The screw that is used to mount the circulator is not accessible without first removing the front panel (see fig. 34).

b. During the test, centrifugal fan B1 of transmit case CY-4637( )/GRC-103 failed twice. One failure caused the tubes to overheat and the plastic type material used to isolate the tubes melted. The plastic type material tuning shaft for the tube adjustments was bent also making adjustment difficult.

c. Part numbers were frequently obliterated during maintenance of the AM-4319/GRC-103 Band IV (see fig. 34).

d. There were six known amplifier, frequency multiplier (40A2) failures during the test. There was no failure analysis received from the contractor for these six failed items.

e. SOMTE comments are shown in appendix E.

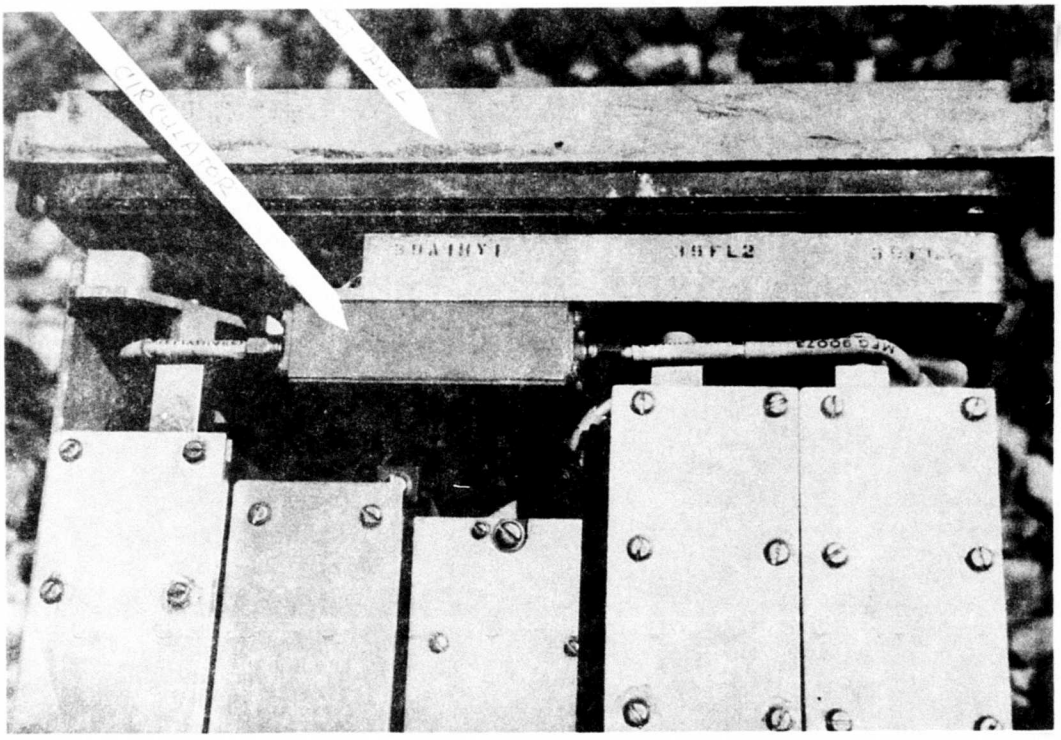


Figure 34. Access to circulator 39A1HY1.

2.47.5.5 Analysis

a. The inaccessibility of the screw is prejudicial to the ease of maintenance, and the requirement to remove the front panel to facilitate removal of the circulator without removal instructions in the equipment publications extends maintenance time.

b. The melting of the plastic type material and the bending of the tube tuning shaft indicate a weakness in design.

c. The ease of obliterating the part numbers is prejudicial to the ease of maintenance and increases maintenance time due to difficulty in identifying part once number is not visible.

d. The six amplifier, frequency multiplier 40A2 failures demonstrate a possible weakness in design which is contrary to minimizing maintenance by using the most reliable components. (See subtest 2.46.)

e. Paragraphs a, c, and d constitute a shortcoming.

2.47.6 STORAGE COMPARTMENTS AND STORAGE COMPONENTS

2.47.6.1 Objective. The objective of this subtest was to determine the adequacy and suitability of the storage compartments and storage components provided with the test item.

2.47.6.2 Criterion. All test item storage compartments and storage components (i.e., clamps, brackets, holding fixtures) shall be sufficient, of adequate size and strength, accessible, and functional with respect to their intended use. (AR 702-3, para 2-5)

2.47.6.3 Data Acquisition Procedure

a. Storage compartments and storage components were inspected and evaluated before and after all moves and during operations. Stored items were checked for damage.

b. Storage compartments, clamps, brackets, and holding fixtures were examined to determine their adequacy, suitability of location, and the ease of removing and replacing the item secured or stored by them.

c. Data pertaining to the storage compartments were evaluated and recorded throughout the test.

2.47.6.4 Results

a. Tube extractor and screw key storage components of amplifier, frequency multiplier AM-4323/GRC-103 Band IV were used throughout the test. No problems were encountered.

b. During the test period, the covers of the spare tube storage compartment and voltage regulator test points were misplaced.

2.47.6.5 Analysis

The storage compartments are adequate; however, the covers for the spare tube storage compartment and voltage regulator test points should be secured to the chassis to preclude misplacing of covers.

SECTION 3. APPENDICES

APPENDIX A. TEST CRITERIA

Item	Source	Requirements	Applicable Subtest	Remarks
1	Approved Test Plan	The test item and maintenance test package shall be complete and in operating condition prior to start of testing.	2.1	Met.
2		The test item shall meet the pertinent safety requirements of the following: a. MIL-STD-454C. b. MIL-STD-1472A.	2.2	Not met. See shortcoming 2.2, app C.
3	EL-CP0150-0001A, para 3.18	The equipment cases housing the individual radio set components shall not exceed the following dimensions: a. Transmitter (with integral power supply and any one tuning unit) depth - 12 inches (292.8 mm); width - 17-3/8 inches (441.20 mm); height - 8-1/2 inches (215.9 mm). b. Receiver (with integral power supply and any one tuning unit) depth - 12 inches (292.8 mm) width - 17-3/4 inches (450.85 mm); height - 8-1/2 inches (215.9 mm).	2.3	Met.
4	EL-CP0150-0001A, para 3.18	The weight of the radio set components when installed in their cases shall not exceed the following: a. Transmitter (with integral power supply and any one tuning unit) - 65 pounds (29.48 kg).	2.3	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
4 (Cont)		b. Receiver (with integral power supply and any one tuning unit) - 65 pounds (29.48 kg). c. Receiver-Transmitter, Order Wire RT-773()/GRC-103(V) - 7.6 pounds (3.44 kg).		
5	MIL-R-55656(EL)	The test item shall not have any of the defects listed in MIL-STD-252B.	2.4	Met.
6	EL-CP0150-0001A, para 3.16	The equipment shall operate from a 115 Vac, 47.5 to 420 Hz, single phase source, having a voltage variation of ±10 percent. The total power drain for a transmitter and receiver shall not exceed 400 watts normal operating conditions.	2.5	Met.
7	EL-CP0150-0001A, para 3.12	Like units, assemblies, subassemblies, and replaceable parts shall be physically and functionally interchangeable, not requiring modification or adjustment except operator adjustments.	2.6	Met.
8	EL-CP0150-0001A, para 3.13.4.1	The normal transmitter power output measured before the RF duplexer shall be at least 15 watts, under operating conditions of room ambient, high and low temperature, humidity, or altitude. The transmitter output power shall be at least 10 watts at 103.5 volts ac line voltage and at least 15 watts for any line voltage in excess of 115 volts.	2.7	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
9	EL-CP0150-0001A, para 3.13.4.2	The transmitter shall have provision for maintaining the high level power tubes within their recommended plate dissipation ratings under conditions of no excitation, or when the RF terminals are open circuited or shorted.	2.8	Met.
10	EL-CP0150-0001A, para 3.13.4.3	The transmitter when set to any channel in any band, after 15-minute warmup and at any ambient temperature between -35° and +125°F (-37.2° and +51.6°C) shall not vary beyond ±0.002 percent of the nominal channel frequency for the next 8 hours. The ambient temperature may vary up to 54°F (12°C) within the prescribed limits during the 8-hour period.	2.9	Met.
11	EL-CP0150-0001A, para 3.13.4.4	It shall be possible to align the transmitter to within 0.002 percent of the desired frequency by the use of an integral indicator, calibrated in RF channel numbers.	2.10	Met.
12	EL-CP0150-0001A, para 3.13.4.6	The visual alarm shall indicate any change in RF power output that is greater than 8 ±1 dB below the nominal power output rating of the transmitter. A push-to-operate switch shall be included such that in one switch position the alarm shall sound when the visual alarms are lighted as in the case of a failure, and in the second switch position the alarm sounds when the light is not lighted.	2.11	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
13	EL-CP0150-0001A, para 3.13.4.7	The overall frequency response of the transmitter shall conform to the specifications outlined in paragraph 2.12.2 of this report.	2.12	Met.
14	EL-CP0150-0001A, para 3.13.4.8	The dummy antenna shall be capable of dissipating the maximum RF power delivered by the transmitter, presenting a non-reactive 50-ohm load over the entire frequency range. The VSWR shall not exceed 1.5.	2.13	Met.
15	EL-CP0150-0001A, para 3.13.11	The impedance at the video input to the transmitter shall be 91 ohms ±5 percent resistive to at least 480 kHz and 91 ohms ±15 percent to at least 800 kHz.	2.14	Met.
16	EL-CP0150-0001A, para 3.13.5.1	The noise figure of the receiver shall not exceed 8 dB. This value shall include the losses due to the receiver protection device and the duplexer.	2.15	Met.
17	EL-CP0150-0001A, para 3.13.5.4	It shall be possible to align the receiver to within 0.002 percent ±10 kHz of the desired frequency by use of an integral indicator, calibrated in RF channel numbers.	2.16	Met.
18	EL-CP0150-0001A, para 3.13.5.4.1	The receiver when set to any channel in the operating range, after 15 minutes warmup and at any ambient temperature between -35° and +125°F (-37.2° and +51.6°C), shall not vary beyond plus and minus 0.002 percent, ±20 kHz of that frequency during the next 8 hours. The ambient may vary up to 54°F (12°C) within the above limits during the 8-hour period.	2.17	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
19	EL-CP0150-0001A, para 3.13.6	The IF selectivity shall have a nominal 3 dB bandwidth of 750 kHz with the response down at least 60 dB at +2.1 MHz or more from resonance.	2.18	Met.
20	EL-CP0150-0001A, para 3.13.7	Receiver protection, in the form of electronic circuitry, shall be provided so that when the transmitter has been tuned for optimum output, it shall be possible to tune the receiver duplexer section through the transmitter frequency without damage to the receiver. The circuitry shall provide protection against external signals at any frequency with a power level up to 43 dBm under all conditions of receiver tuning. The protective circuitry shall not degrade the receiver noise figure greater than 0.750 dB.	2.19	Met.
21	EL-CP0150-0001A, para 3.13.8	The overall frequency response of the receiver when a frequency modulated signal of constant deviation (100 kHz peak) is applied to the receiver antenna terminal and measured at the video output terminal shall conform to the specifications outlined in paragraph 2.20.2 of this report.	2.20	Met.
22	EL-CP0150-0001A, para 3.13.11	The output impedances of the receiver shall be 91 ohms ±5 percent resistive to at least 1 MHz for the regenerated 6/12-channel PCM output and 51 ohms ±10 percent resistive for the 24-channel PCM output to at least 800 kHz.	2.21	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
23	EL-CP0150-0001A, para 3.13.16.3	A squelch shall disable the regenerated PCM signal when the signal-to-noise ratio at the unregenerated video output is less than 7 ±2 dB with a reference deviation of ±180 kHz peak. An audible and visible alarm shall operate in conjunction with the squelch to indicate locally a failure of the received signal from the remote station. A reversing switch shall be provided on the front panel such that regardless of the level of signal input to the receiver, the audible alarm can be disabled. The sensitivity of the squelch circuit shall be such that the point of operation which indicates a received signal (lamp extinguished) shall be -98 dBm ±3 dB.	2.22	Met.
24	EL-CP0150-0001A, para 3.13.10	The radio set shall provide for transmission of signals from Multiplexers TD-352, TD-353, TD-660, and TD-754. These signals are briefly described below:	2.23	Met.

PCM Characteristics

Number of channels	6	12	24
Signal Form	(Full-band, Unipolar Binary)		(Biternary combination of two 12 channel signals)
Bit Rate	288 kHz		576 kHz

Pulse width at half amplitude 3.472 µsec, 1.736 µsec.

Item	Source	Requirements	Applicable Subtest	Remarks
25	EL-CP0150-0001A, para 3.13.12	The overall frequency response between transmitter video input and receiver video output relative to the response at 10 kHz shall conform to the specifications outlined in paragraph 2.24.2 of this report.	2.24	Met.
26	EL-CP0150-0001A, para 3.13.13	The type of modulation used in the transmitter shall be frequency modulation. The rated peak deviation of the transmitter shall be plus and minus 300 kHz. The modulation sensitivity of the transmitter shall be continuously variable with the maximum sensitivity of plus and minus 300 kHz peak with an input voltage of 1 volt peak-to-peak. The receiver regenerated output shall be 2 volts ±10 percent when receiving a signal with peak deviation plus and minus 180 kHz. The receiver unregenerated output shall be 0.75 volt ±0.25 volt peak-to-peak when receiving a signal with the rated peak deviation plus and minus 300 kHz.	2.25	Met.
27	EL-CP0150-0001A, para 3.13.13	Metering circuitry shall be provided in the equipment to enable the operator to perform the following in the absence of external test equipment: a. Adjust the peak deviation of the transmitter to plus and minus 180 kHz and plus and minus 300 kHz with an accuracy of plus 2.2 and minus 1.0 dB with inputs from 1 to 4 volts (peak-to-peak).	2.26	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
27 (Cont)		b. Establish that the regenerated receiver output is 2 volts ±10 percent when receiving a signal with peak deviation of plus and minus 180 kHz, and that the unregenerated receiver output is 0.75 ±0.25 volts (peak-to-peak) when receiving a signal with peak deviation of plus and minus 300 kHz.		
28	EL-CP0150-0001A, para 3.13.14	The transmitter shall be adjusted for a peak deviation of plus and minus 180 kHz. Under these conditions, the ratio of average detected signal power to the average noise power at the unregenerated video output terminal of the receiver shall be at least 12 dB when the received RF signal is -94 dBm, and at least 31 dB when the received RF signal is -74 dBm. The transmitter shall be adjusted for rated peak deviation (plus and minus 300 kHz), the ratio shall be at least 16 dB when the received RF signal is -94 dBm, and at least 35 dB when the received signal is -74 dBm.	2.27	Met.
29	EL-CP0150-0001A, para 3.13.15	The total harmonic distortion at any frequency between 250 Hz to 240 kHz, measured at the unregenerated video output terminal shall not exceed a level 26 dB below the fundamental of 10 kHz.	2.28	Met.
30	EL-CP0150-0001A, para 3.13.16	The regeneration shall eliminate all noise peaks less than 40 percent of the pulse amplitude for the range of unregenerated video output levels corresponding to input deviations of plus and minus 145 kHz peak	2.29	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
30 (Cont)		minimum to plus and minus 230 kHz peak maximum. The regenerated signal amplitude shall be -0.1 +0.1 volt for the '1' condition and -2.0 ±0.2 volts for the '0' condition, delivered into a load of 91 ohms ±5 percent with no reversal of phase from the transmitter input or unregenerated video output. Pulse width shall be full interval with 10 to 90 percent rise time of 20.0 nsec minimum, 50 nsec maximum. The 50 percent point shall be 0 nsec minimum, 80 nsec maximum after the 50 percent point of the rising edge of the timing signal specified below. The timing signal amplitude shall be 2.0 ±0.2 Vdc isolated, delivered into a load of 91 ohms ±5 percent. Pulse width at the 50 percent amplitude point shall be 90 nsec minimum, 150 nsec maximum. Rise time of the leading edge from the 10 percent point to the 90 percent point shall be 20 nsec minimum, 50 nsec maximum. Pulse rate shall be 576 kHz for both the 6 channel and 12 channel signals.		
31	EL-CP0150-0001A, para 3.13.37	The duplexers shall have minimum pass-band insertion loss. Insertion loss at the center frequency of the pass-band of the transmitter section shall not exceed 2 dB over the operating band.	2.30	Met

Item	Source	Requirements	Applicable Subtest	Remarks
32	EL-CP0150-0001A, para 3.13.37.2	The duplexers shall be continuously tunable over their respective frequency ranges. To facilitate tuning, metering shall be incorporated to indicated power transmitted to the antenna from the duplexer, and the power reflected from the antenna back to the duplexer. The controls shall be calibrated in channel numbers accurately enough to permit their tuning, without special equipment, to meet the operational requirements of this specification.	2.31	Met.
33	EL-CP0150-0001A, para 3.15	The system gain shall not vary more than ±1.0 dB in any 8-hour period between the transmitter video input and the receiver video output terminals when the received signal is varied between -95 and -45 dBm.	2.32	Met.
34	EL-CP0150-0001A, para 3.15.1	A transmitter shall be tuned to any channel in its operating band and coupled to an antenna through the duplexer. With the receiver connected to the same antenna through the duplexer, there shall be a minimum of eight channels unusable by the receiver, exclusive of the channels in a 20 MHz band centered around the transmitter frequency. An unusable channel shall be defined as a channel on which the receiver cannot receive a remote signal level of -94 dBm, para 3.13.9 (Signal-to-Noise) of the specification.	2.35	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
35	EL-CP0150-0001A, para 3.25	The test item shall meet the emission and susceptibility requirements of MIL-STD-461A, Notice 4, Table A-1 as follows: CE04, CE06, CS01, CS02, CS04, CS06, RE02, RE02.1, and RS03.2.	2.36	Met.
36	EL-CP0150-0001A, paras 3.21.1.1, and 4.10.1.1	The test item shall not exhibit any physical damage or degradation of performance following storage at -65°F (-54.3°C) and operation at -35°F (-37.2°C).	2.37	Met.
37	EL-CP0150-0001A, paras 3.21.1.2 and 4.10.1.2	The test item shall exhibit no physical damage or degradation in performance following storage at 155°F (68.9°C) and operation at 125°F (51.6°C).	2.38	Met.
38	EL-CP0150-0001A, paras 3.21.2 and 4.10.2	The test items shall exhibit no physical damage or deterioration in operational performance when subjected to a high humidity environment.	2.39	Not met. See deficiency 1.1, app C.
39	EL-CP0150-0001A, paras 3.21.3 and 4.10.3	The equipment shall meet full specification performance during and after testing as specified in paragraph 4.10.3.	2.40	Met.
40	EL-CP0150-0001A, paras 3.21.3 and 4.10.3	The equipment shall be tested in accordance with Method 500, Procedure 1, of MIL-STD-810B. The chamber may be returned to ambient atmospheric pressure for frequency changes.	2.40	Met.
41	EL-CP0150-0001A, paras 3.21.4 and 4.10.4.3	The equipment shall be tested in accordance with Method 516.1, Procedure V, of MIL-STD-810B. Prior to and after testing the equipment shall meet full specification performance.	2.41	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
42	EL-CP0150-0001A, paras 3.21.4 and 4.10.4.1	The equipment shall be tested in accordance with MIL-STD-810B, Method 514, Procedure IV, Part 1. Prior to and after testing the equipment shall meet full specification performance.	2.42	Not Met.
43	EL-CP0150-0001A, paras 3.21.4 and 4.10.4.1	The test item shall be subjected to sinusoidal vibration in its three mutually perpendicular axes, consisting of logarithmic cycling from 5 to 500 to 5 Hz. The sweep rate shall be 5 to 500 to 5 Hz in 15 minutes. Vibratory inputs to the test item shall be 1 inch double amplitude constant displacement from 5 to 5.5 Hz, 1.5 G's peak constant acceleration from 5.5 to 30 Hz, 0.033 inch double amplitude constant displacement from 30 to 50 Hz, and 1.5 G's peak constant acceleration from 50 to 200 Hz. Total test times shall be 330 minutes per axis of vibration. Operational tests shall be performed after each axis of operation.	2.42	Not Met.
44	EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7	The ratio of the half-power (-3 dB) E- and H-plane beamwidth shall not exceed 2.0:1 over the frequency range.	2.43	Met.
45	EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7	The gain of the antenna measured in the direction of the normal from the antenna shall not differ from the maximum gain measured at any frequency in the operating range by more than 0.5 dB.	2.43	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
46	EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7	The ratio of major lobe of the antennas to any minor lobe shall be at least 20 dB at any frequency in the operating range.	2.43	Met.
47	EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7	The gain of the antenna shall be at least 18 dB at 1350 MHz and 20 dB at 1850 MHz relative to an isotropic radiator.	2.43	Met.
48	EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7	The VSWR measured at the antenna terminals shall not exceed 1.75:1 over the operating frequency range.	2.43	Met.
49	EL-CP0150-0001A, paras 3.14.4, 3.14.5, 3.14.6, and 3.14.7	The nominal impedance of the antenna shall be 50.0 ohms.	2.43	Met.
50	Approved Test Plan	The overall system performance should be at least as good as the unmodified assemblages.	2.44	Met. See para 2.44.4
51	MIL-STD-1472B, para 5.2	Displays of the test item shall present needed information clearly and shall be visible from all reasonable viewing angles.	2.45	Met.
52	MIL-STD-1472B, para 5.5	Components of the test item that must be located, identified, read, or manipulated shall be appropriately and clearly labeled to permit rapid and accurate human performance.	2.45	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
53	MIL-STD-1472B, para 5.9.11.3	The weight and special precautions in lifting shall be indicated on the compartments of the test item.	2.45	Met.
54	MIL-STD-1472B, para 5.9.14	Cables shall be labeled to indicate the receptacles which they mate. The cable plugs shall be so designed that it will be impossible to insert a wrong plug into a receptacle whenever the possibility exists. Connectors shall be spaced far enough apart that they can be grasped firmly for connecting and disconnecting.	2.45	Met.
55	MIL-STD-1472B, para 3.2	The engineering traits of the test item shall be compatible with human limitations and capacities.	2.45	Met.
56	EL-CP0150-0001A, para 3.23.1	The test items, excluding the GFE, shall have a specified MTBF of 3000 hours. These requirements apply when the test items are used in the following manner: Ambient Temperature - - $40^{o} \pm 5^{o}C$ Duty Cycle - - - - - - - Continuous operation Environment - - - - - - Vehicular ground mounted. (NOTE: There is no established minimum acceptable value (MAV) MTBF, per AR 702-3, for the test item.)	2.46	Not met. See deficiency 1.3, app C.
57	AR 702-3, para 2-5	The equipment publications contained in the maintenance test package shall be complete, accurate, easy-to-read, consistent in nomenclature, simple to follow, and adequate to permit completion of	2.47.2	Not met. See deficiency 1.4, app C.

Item	Source	Requirements	Applicable Subtest	Remarks
57 (Cont)		both scheduled and unscheduled maintenance operations and parts acquisition at all field levels of maintenance. Draft Army equipment publications shall conform in content and format to that specified in AR 310-3, MIL-M-38784, and MIL-M-63000 (TM) series of military specifications, as applicable.		
58	AR 702-3, para 2-5	Repair parts shall be authorized in adequate quantities and diversity at the appropriate maintenance levels, consistent with the MAC, RPSTL, and skills required to install and align the parts. Repair parts which are used to maintain the system must be interchangeable with like parts being replaced.	2.47.3	Not met. See deficiency 1.4 and shortcoming 2.3, app C.
59	AR 702-3, para 2-5	The special tools and test equipment outlined in the maintenance literature and/or contained in the maintenance test package shall be necessary and adequate for the performance of all required maintenance tasks at all field levels of maintenance when used in conjunction with the authorized common tools and test equipment contained in the applicable tool kits. Whenever possible, the design of a system should accommodate the use of common tools rather than special tools. Complicated test equipment requiring frequent calibration and restrictive environmental control conditions should be avoided.	2.47.4	Met.

Item	Source	Requirements	Applicable Subtest	Remarks
60	AR 702-3, para 2-5	Systems shall be designed to eliminate deficiencies prejudicial to ease of maintenance. System design shall be directed toward minimizing maintenance by using the most reliable components, modular construction, built-in simple fault isolation test indicators, and other technological advances in components and methods to the maximum extent practicable. Means to achieve ease of maintenance include -- a. The location of high mortality parts to provide ready access when maintenance is required. b. The use of readily accessible test points to reduce diagnostic time. c. The reduction in number of types and sizes of common fasteners (i.e., bolts, nuts, screws) and the use of quick-release fasteners, wing nuts, and other features which will minimize requirements for special or additional tools.	2.47.5	Not met. See shortcoming 2.3, app C.
61	AR 702-3, para 2-5	All test item storage compartments and storage components (i.e., clamps, brackets, holding fixtures) shall be sufficient, of adequate size and strength, accessible, and functional with respect to their intended use.	2.47.6	Met.

APPENDIX B. TEST DATA

Field Notes, GRC-103 Antenna Tests.

1. General test layout was set up as shown in figure 35. It will be noted that these distances and heights are over necessary limits.

2. Gain measurements (patterns 1, 2, and 3) were accomplished as shown by figures 36 and 37. "Sig In" was maintained at a constant -10 dBm for both test setups and for all three frequencies. Figure 36 was utilized first (antenna of unknown gain), then our AT-428 of figure 37 was substituted for the unknown. Gain of both AT-428's will be furnished your organization as soon as they are obtained.

3. All azimuth cuts were made in a horizontal plane with the receiving antenna located on the "arc" at the 90-degree point (level with the GRC-103 antenna under test).

4. All azimuth patterns were made with the transmitting antenna (GRC-103) turning with the turntable in a clockwise direction and the receiving antenna remaining stationary. Therefore, the degree markings to be used on the polar plots are the ones that increase in a counterclockwise direction (the boresight of the GRC-103 remaining a 0 degree).

5. All vertical cuts were made with the turntable and GRC-103 antenna in a stationary position and the patterns were recorded with the receiving AT-428 antenna being moved up the "arc" from 95 degrees (5 degrees below horizontal) to 30 degrees (60 degrees above the horizontal), the GRC-103 being boresighted at 90 degrees. Degree markings on the vertical cuts indicate degrees below a vertical line from the antenna under test.

6. Vertical cuts were made only on the main lobe and minor lobes that appeared rather large on the azimuth cuts.

7. DB markings on the polar plots (0 to 40) indicate relative power one way.

8. A cross polarization check was made at all three frequencies by changing the GRC-103 radiating element from vertical or horizontal polarization. (The receiving AT-428 was kept in vertical polarization throughout the entire test.) All resulting signals were at least 40 dB down (out of our dynamic range) and therefore were not recorded.

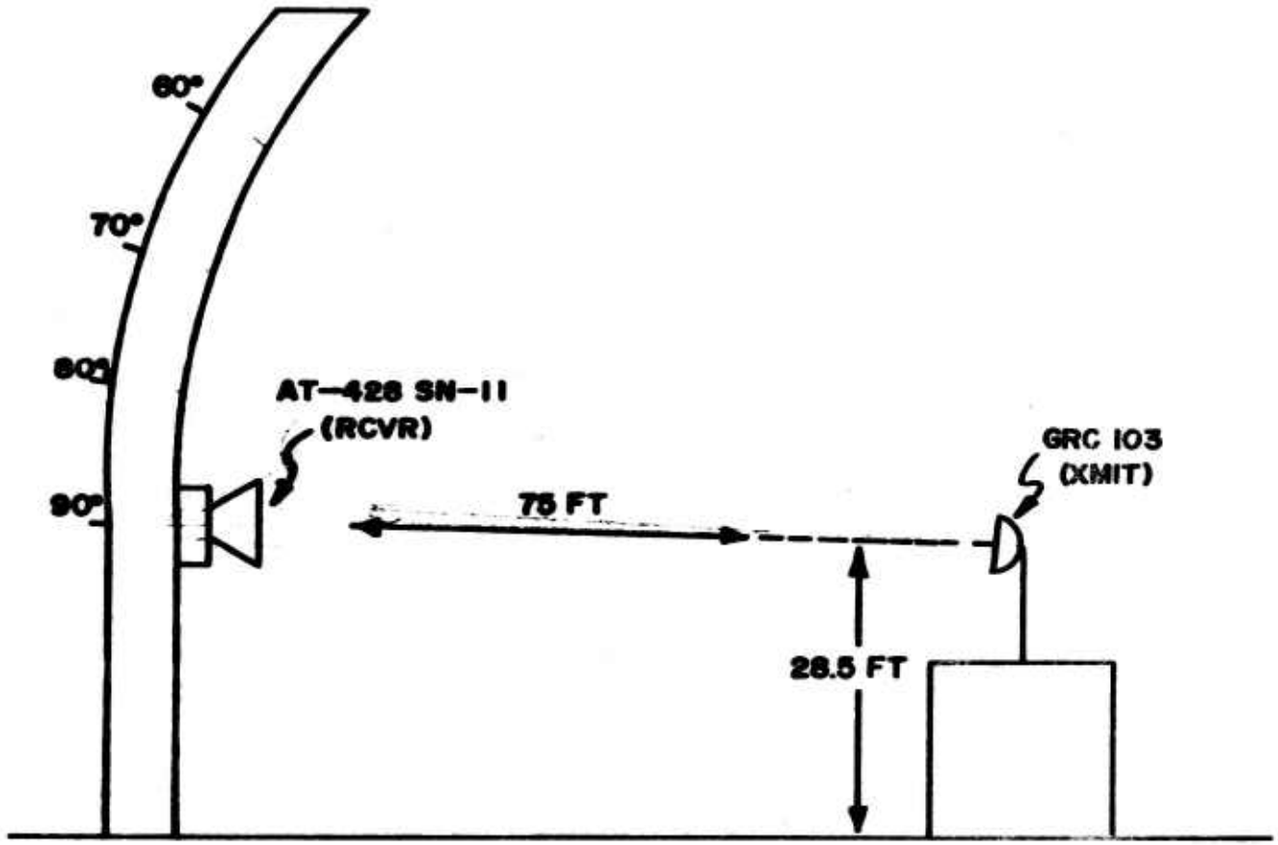


Figure 35. General test setup.

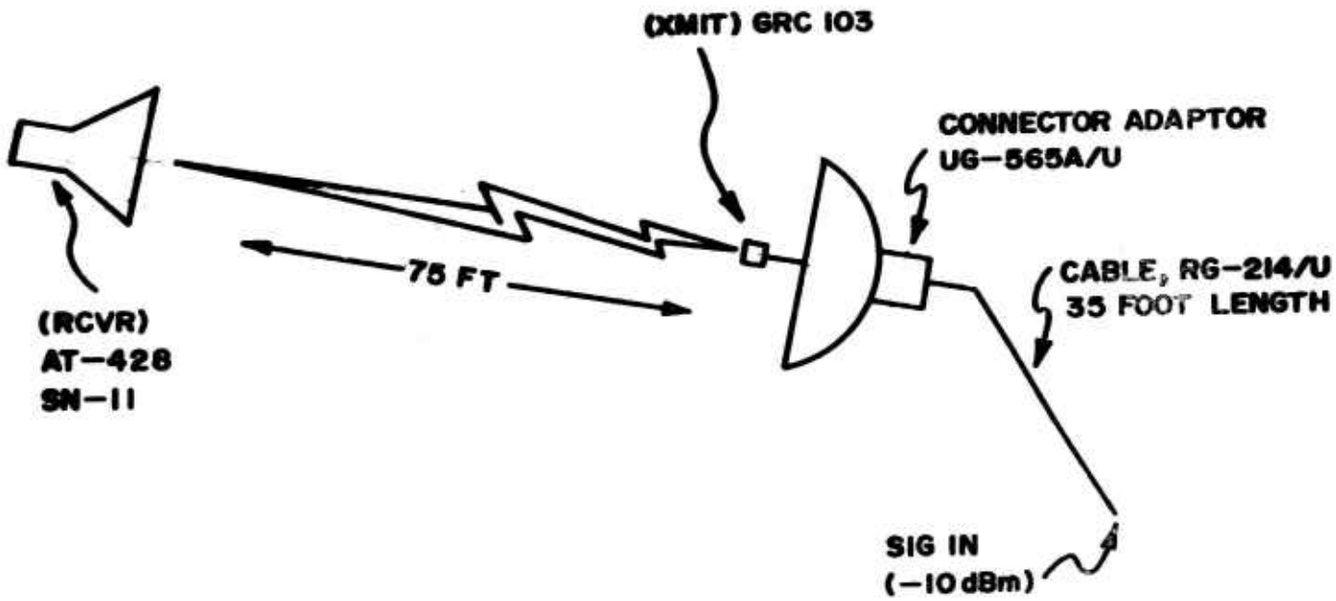


Figure 36. Antenna gain measurements test setup No. 1.

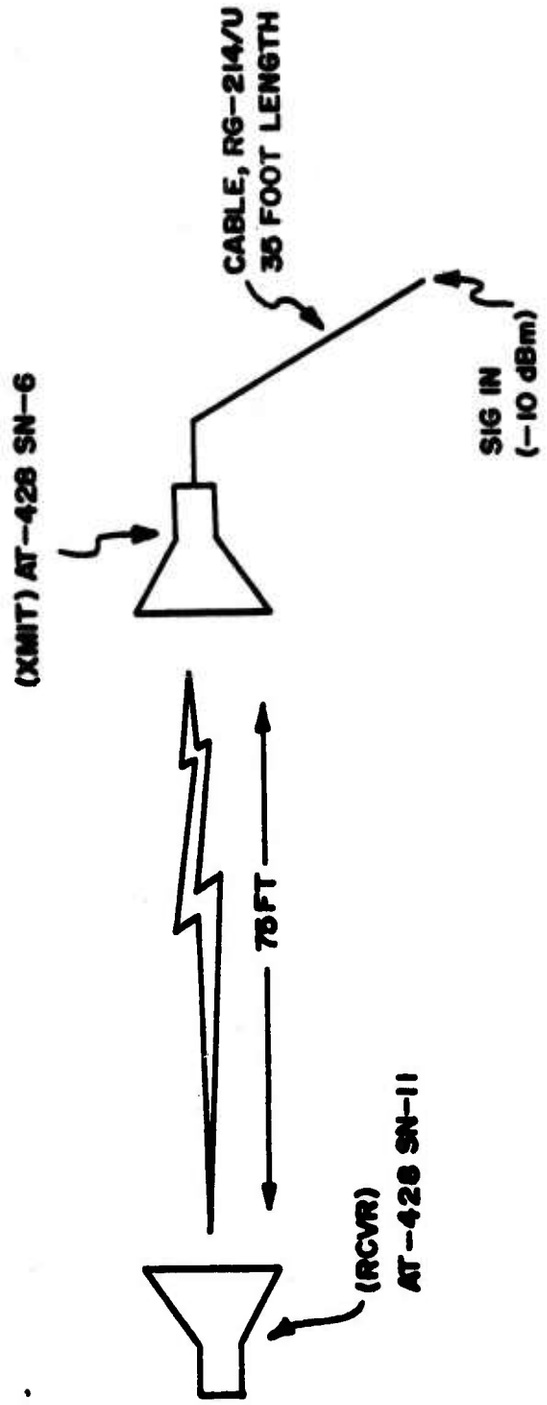


Figure 37. Antenna gain measurements test setup No. 2.

GRC-103 ANTENNA PATTERNS

Pattern No.	Turntable Azimuth	Rec Ant on Arc (degrees)	Transmit Polarization	Receive Polarization	Freq. (GHz)	Remarks
1	---	90	V	V	1.35	Gain, Figs. 36, 37
2	--	90	V	V	1.6	Gain, Figs. 36, 37
3	---	90	V	V	1.85	Gain, Figs. 36, 37
4	0-360	90	V	V	1.85	Az Cut
5	0-360	90	V	V	1.6	Az Cut
6	0-360	90	V	V	1.35	Az Cut
7	0	95-30	V	V	1.35	Vert Cut
8	28	95-30	V	V	1.35	Vert Cut
9	90	95-30	V	V	1.35	Vert Cut
10	180	95-30	V	V	1.35	Vert Cut
11	270	95-30	V	V	1.35	Vert Cut
12	332	95-30	V	V	1.35	Vert Cut
13	0	95-30	V	V	1.6	Vert Cut
14	22	95-30	V	V	1.6	Vert Cut
15	90	95-30	V	V	1.6	Vert Cut
16	180	95-30	V	V	1.6	Vert Cut
17	270	95-30	V	V	1.6	Vert Cut
18	338	95-30	V	V	1.6	Vert Cut
19	0	95-30	V	V	1.85	Vert Cut
20	90	95-30	V	V	1.85	Vert Cut
21	180	95-30	V	V	1.85	Vert Cut
22	270	95-30	V	V	1.85	Vert Cut
23	0-360	90	V	V	1.85	Az, Confirm Check
24	0-360	90	V	V	1.6	Az, Confirm Check
25	0-360	90	V	V	1.35	Az, Confirm Check

Antenna (SN 11)

1.35 GHz	1.60 GHz	1.85 GHz
13.81 dB Gain	14.34 dB Gain	15.57 dB Gain

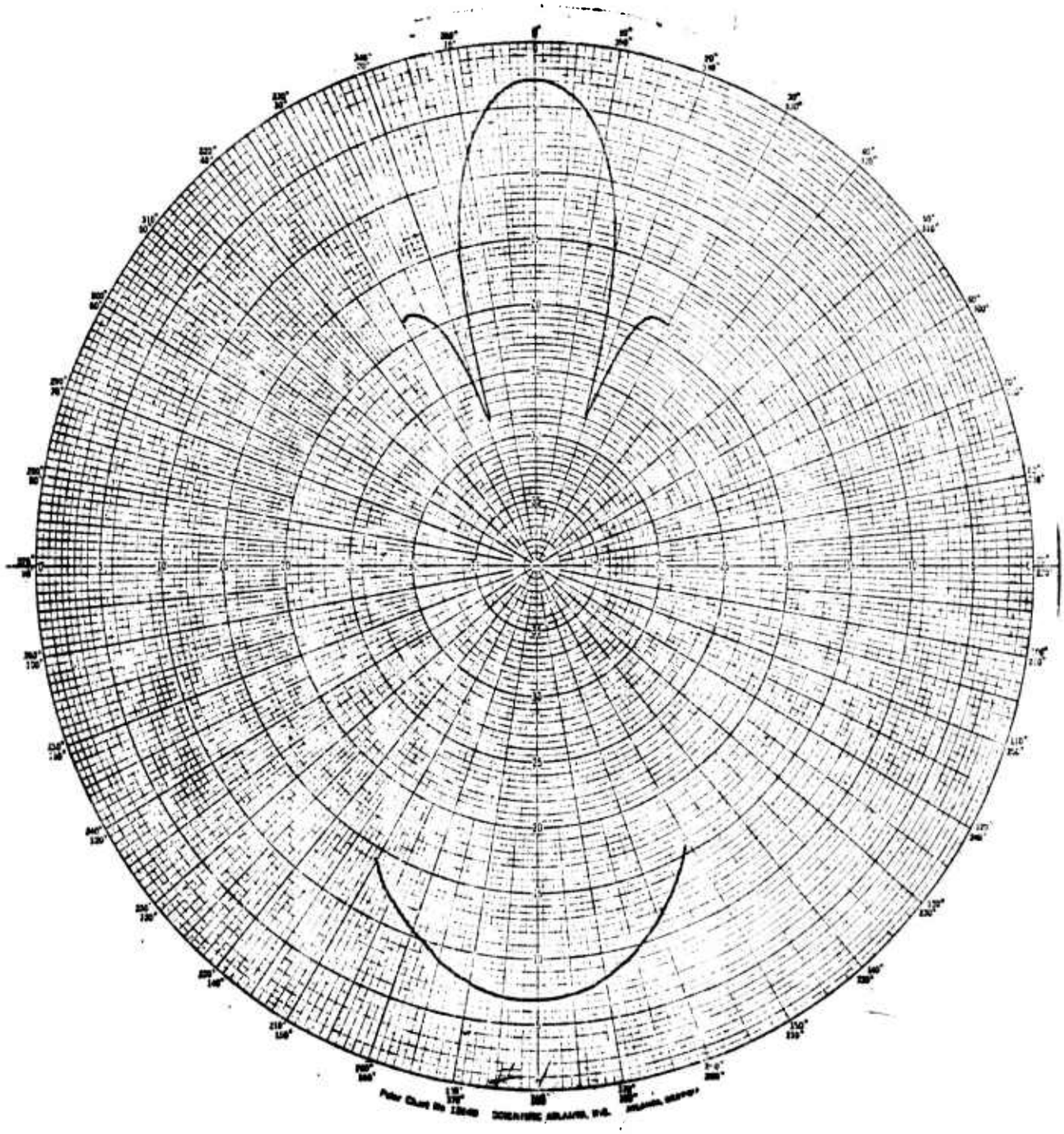


Figure 38. Antenna Pattern No. 1.

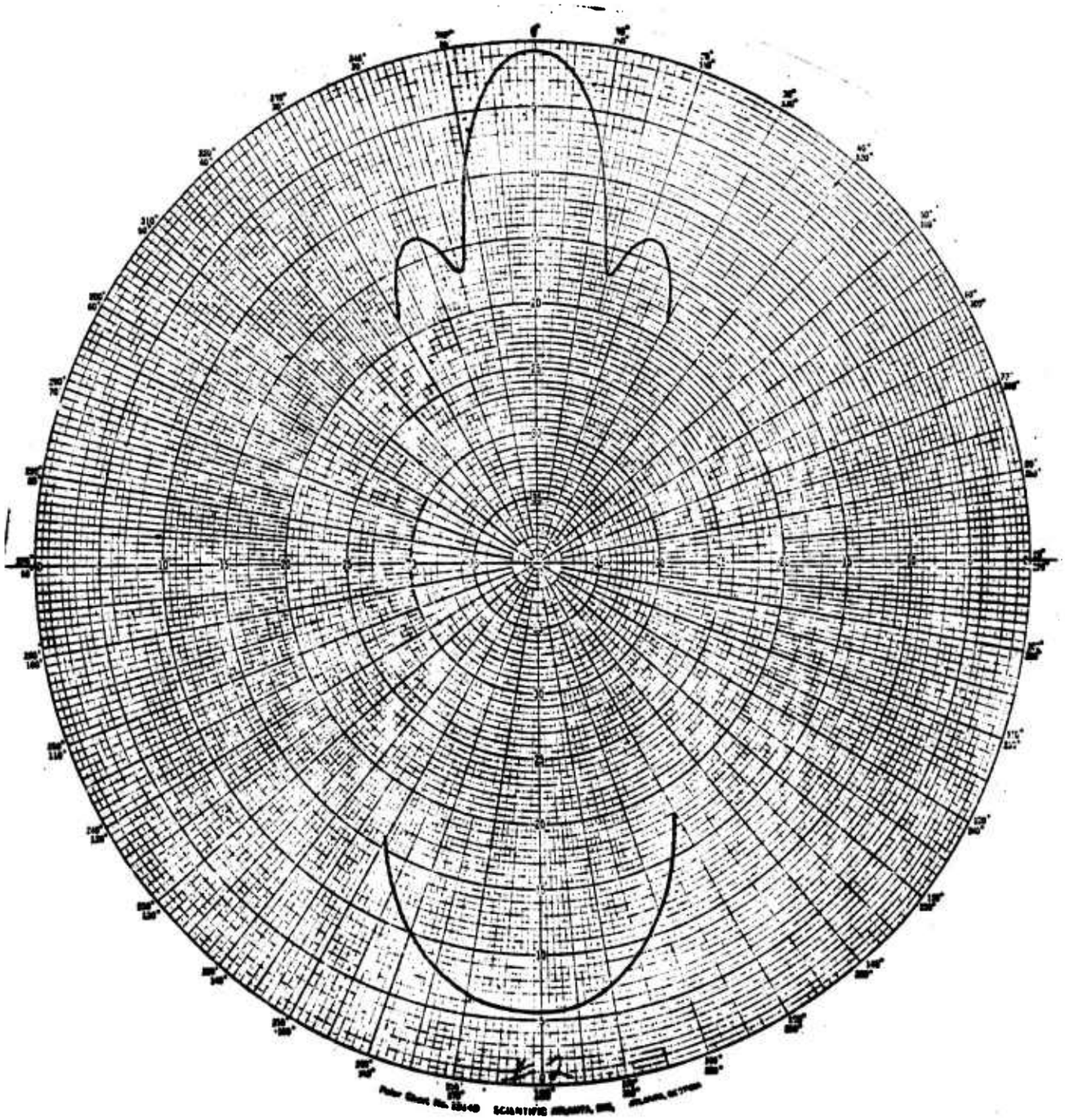


Figure 39. Antenna Pattern No. 2.

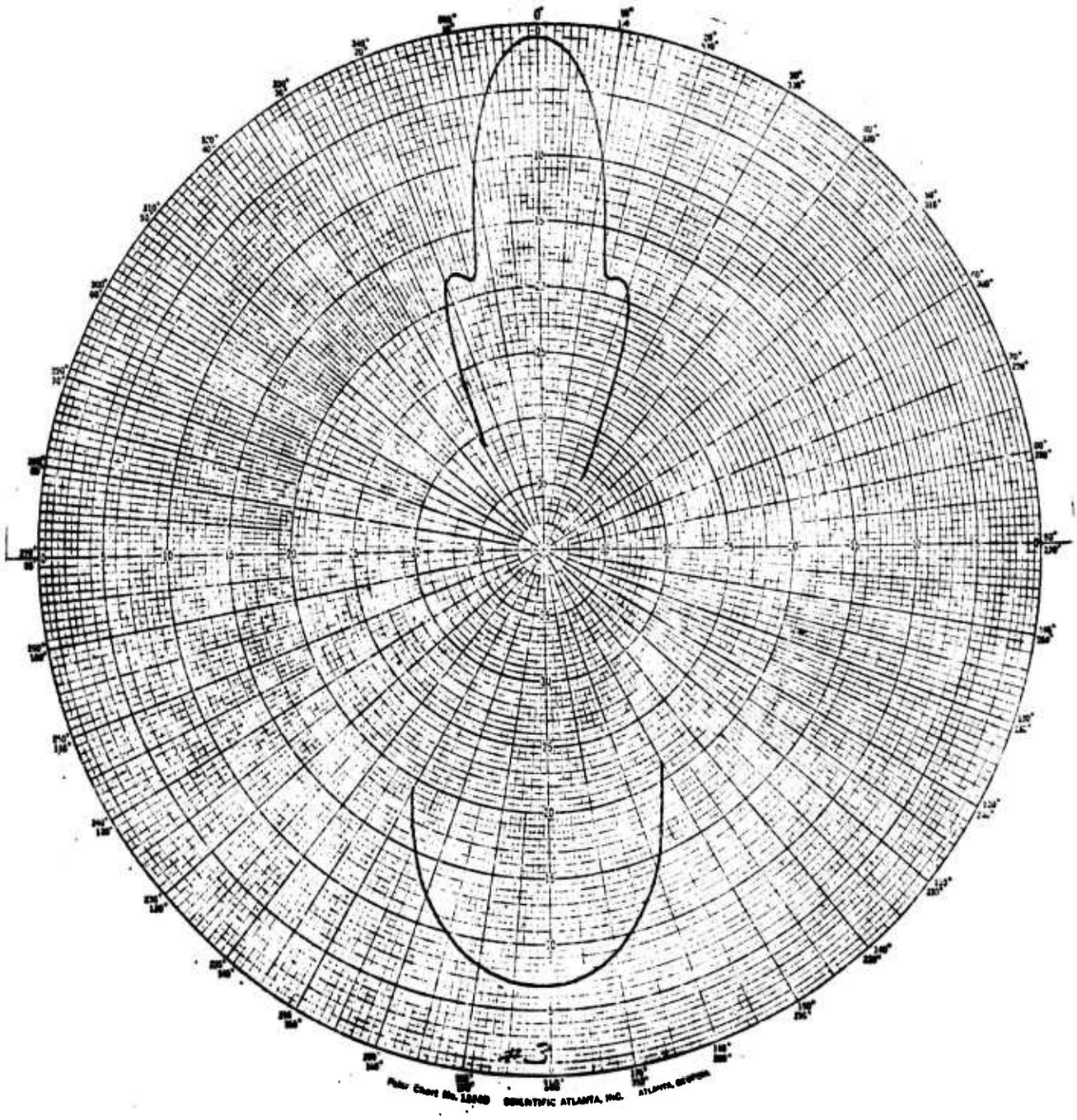


Figure 40. Antenna Pattern No. 3.

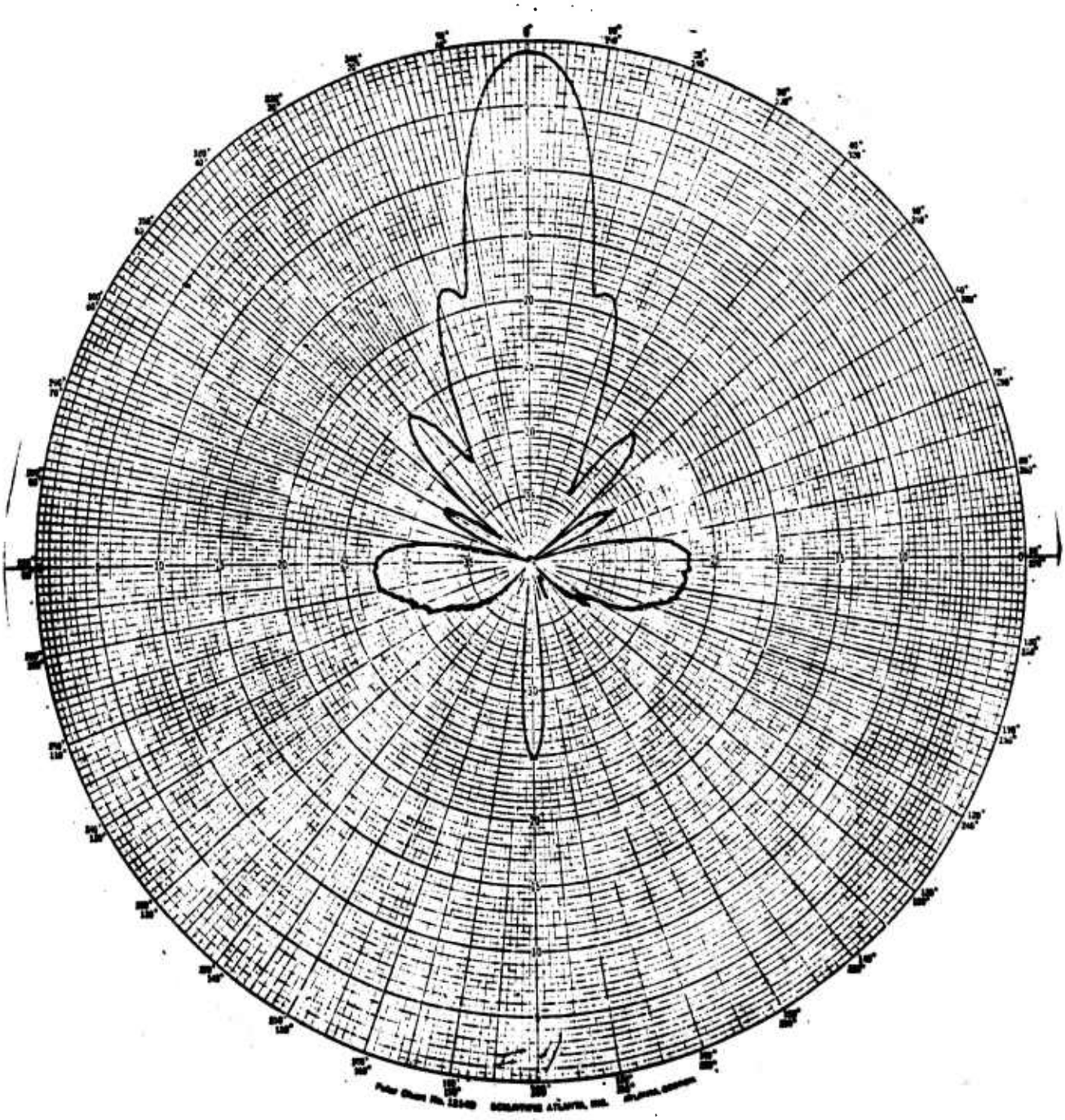


Figure 41. Antenna Pattern No. 4.

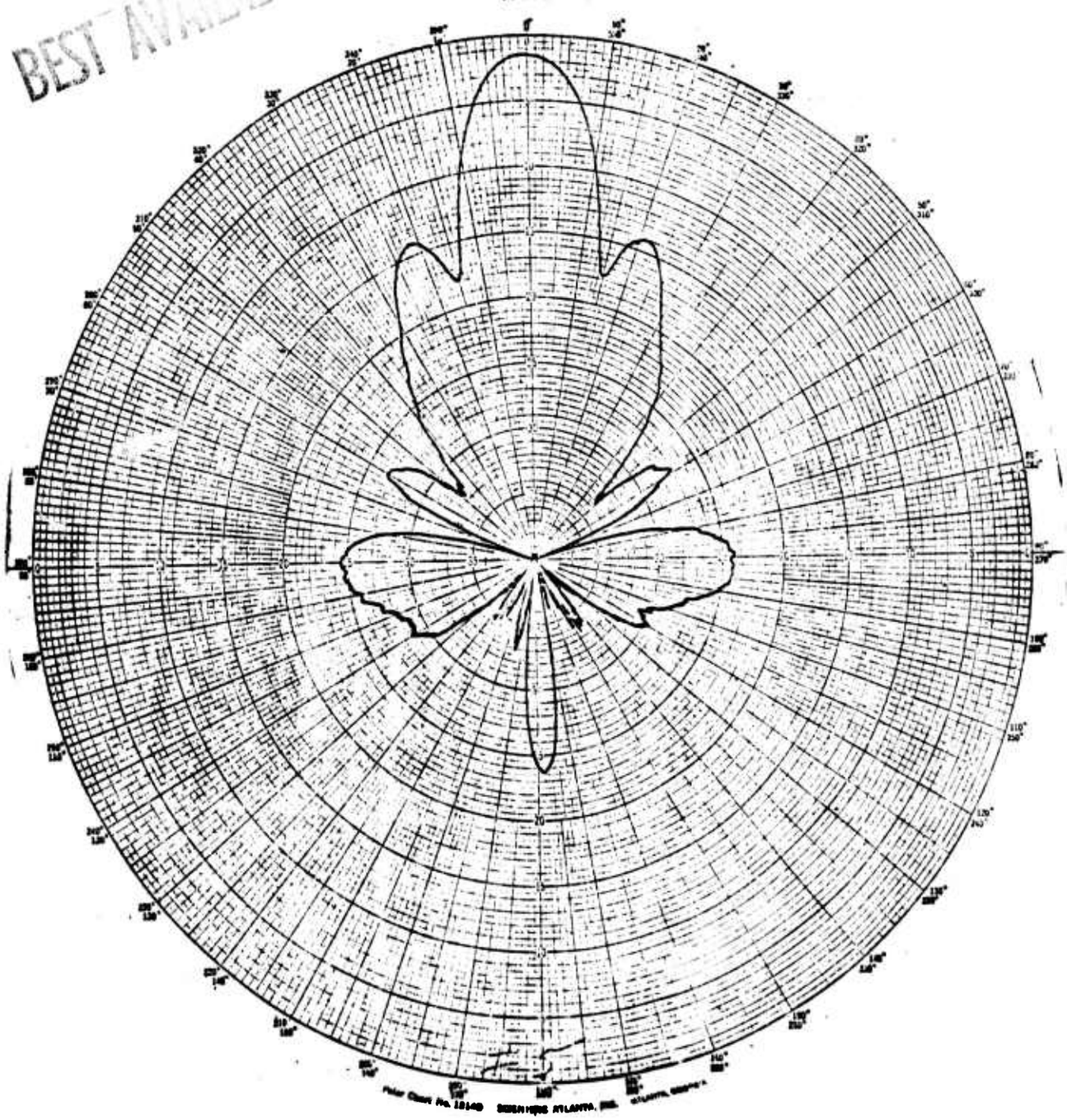


Figure 42. Antenna Pattern No. 5.

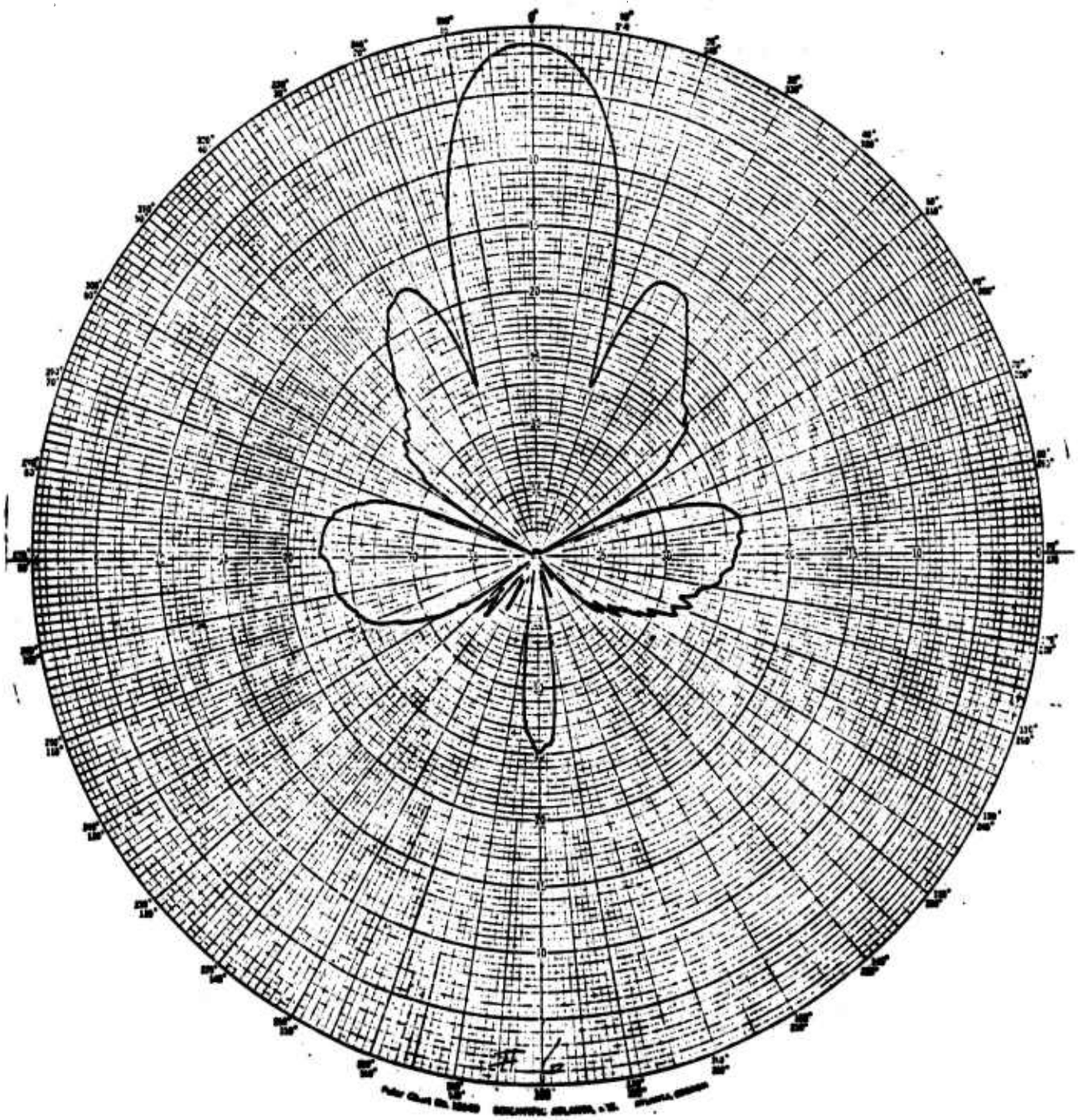


Figure 43. Antenna Pattern No. 6.

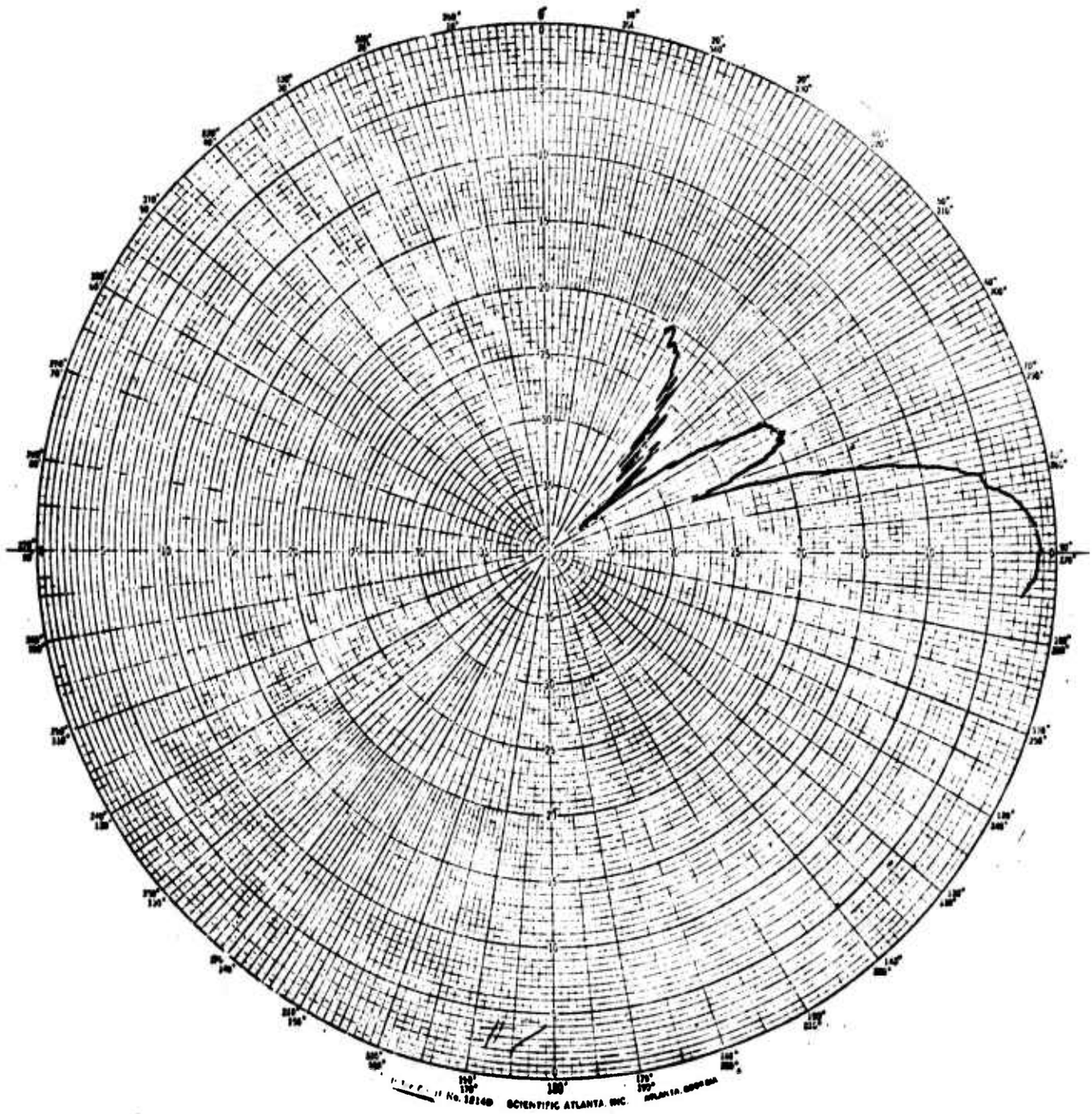


Figure 44. Antenna Pattern No. 7.

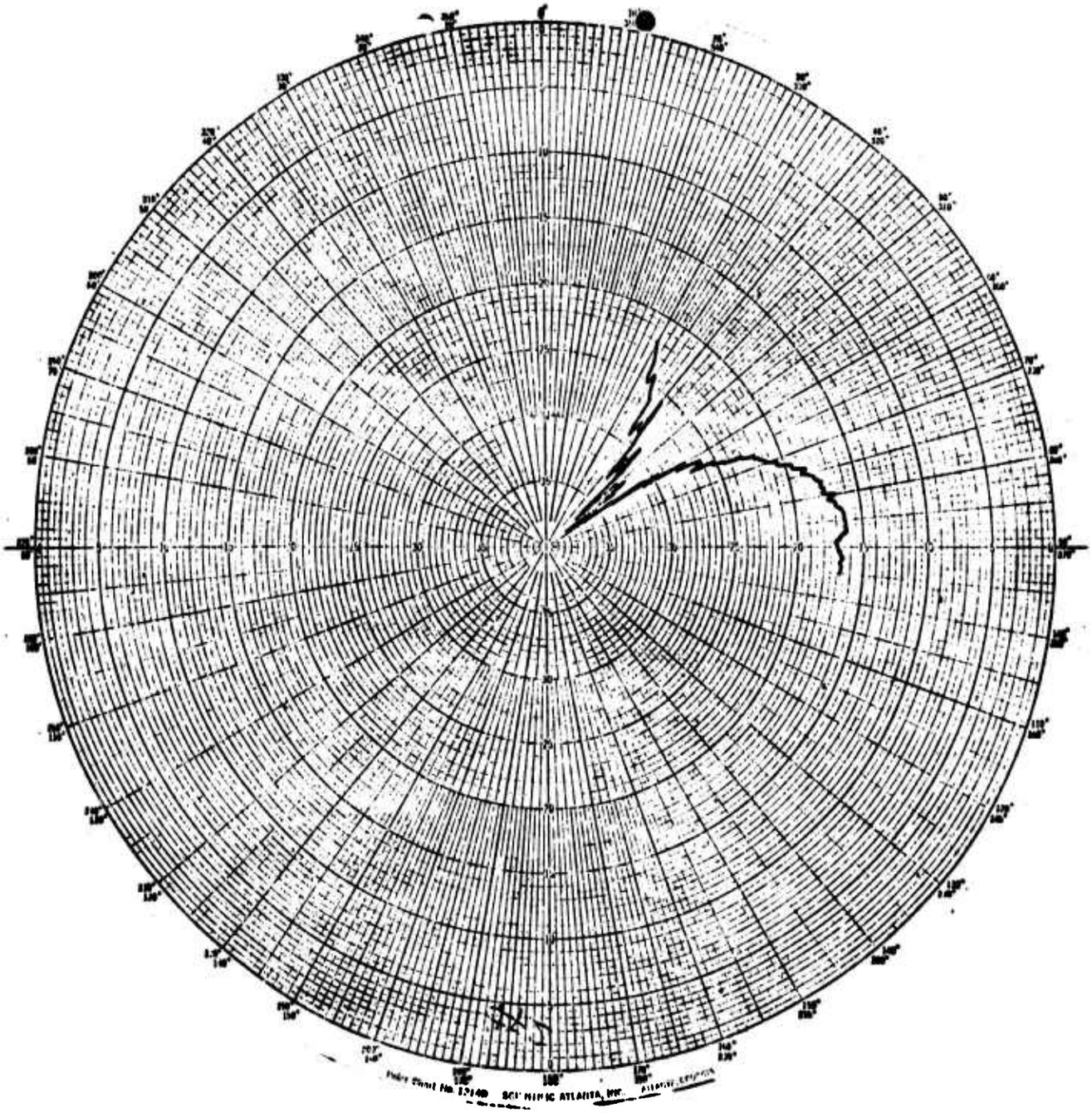


Figure 45. Antenna Pattern No. 8.

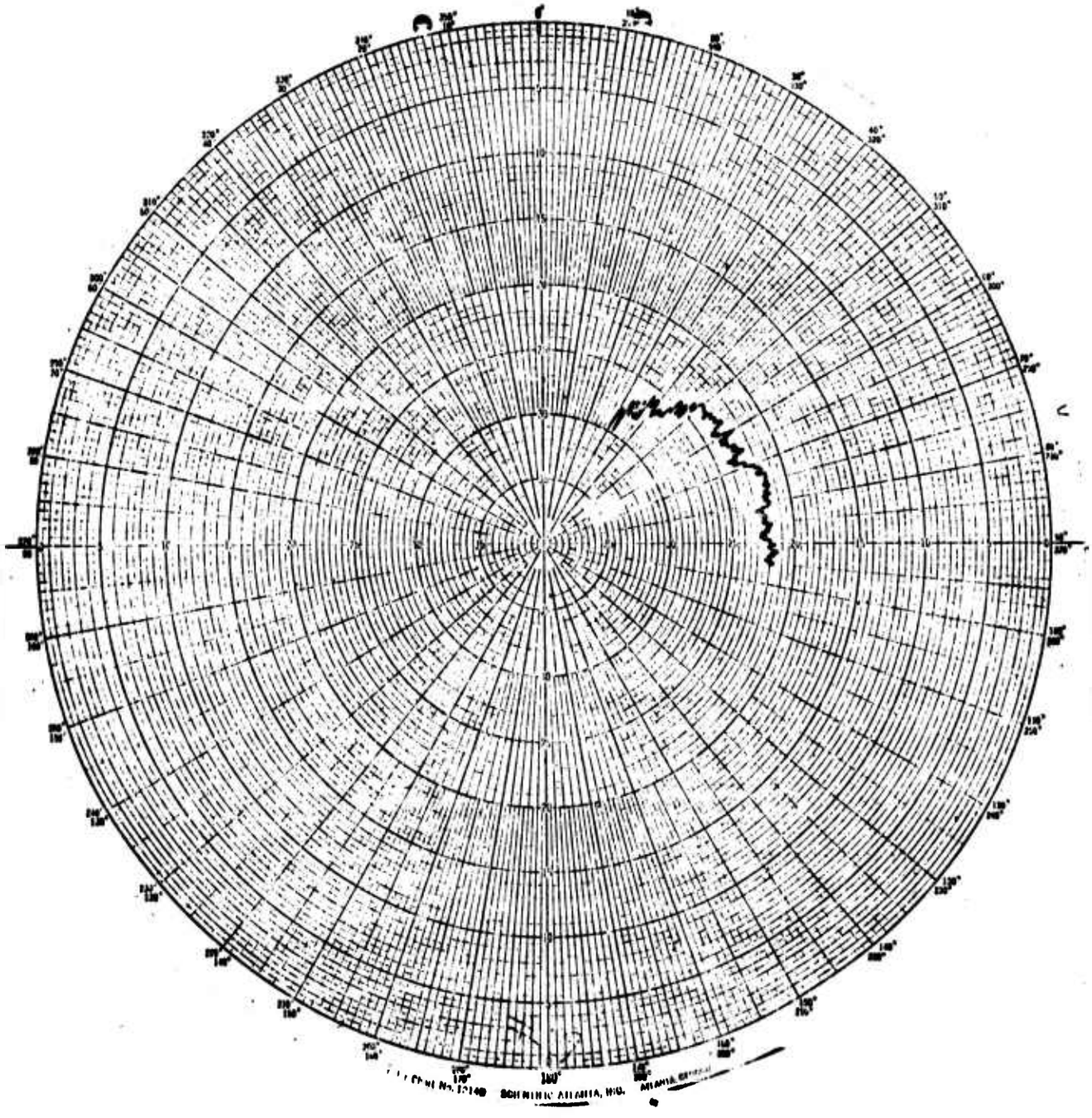


Figure 46. Antenna Pattern No. 9.

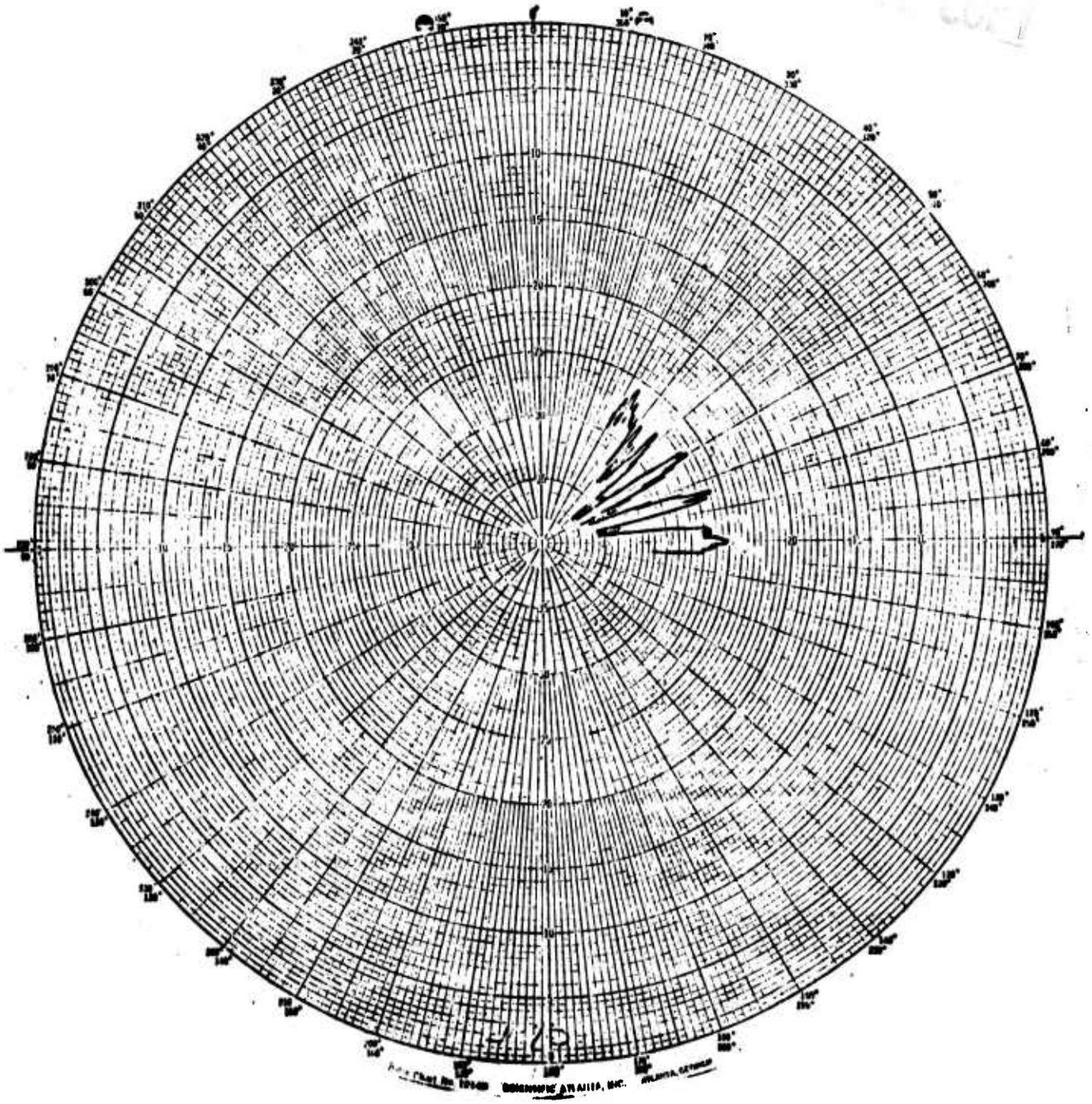


Figure 47. Antenna Pattern No. 10.

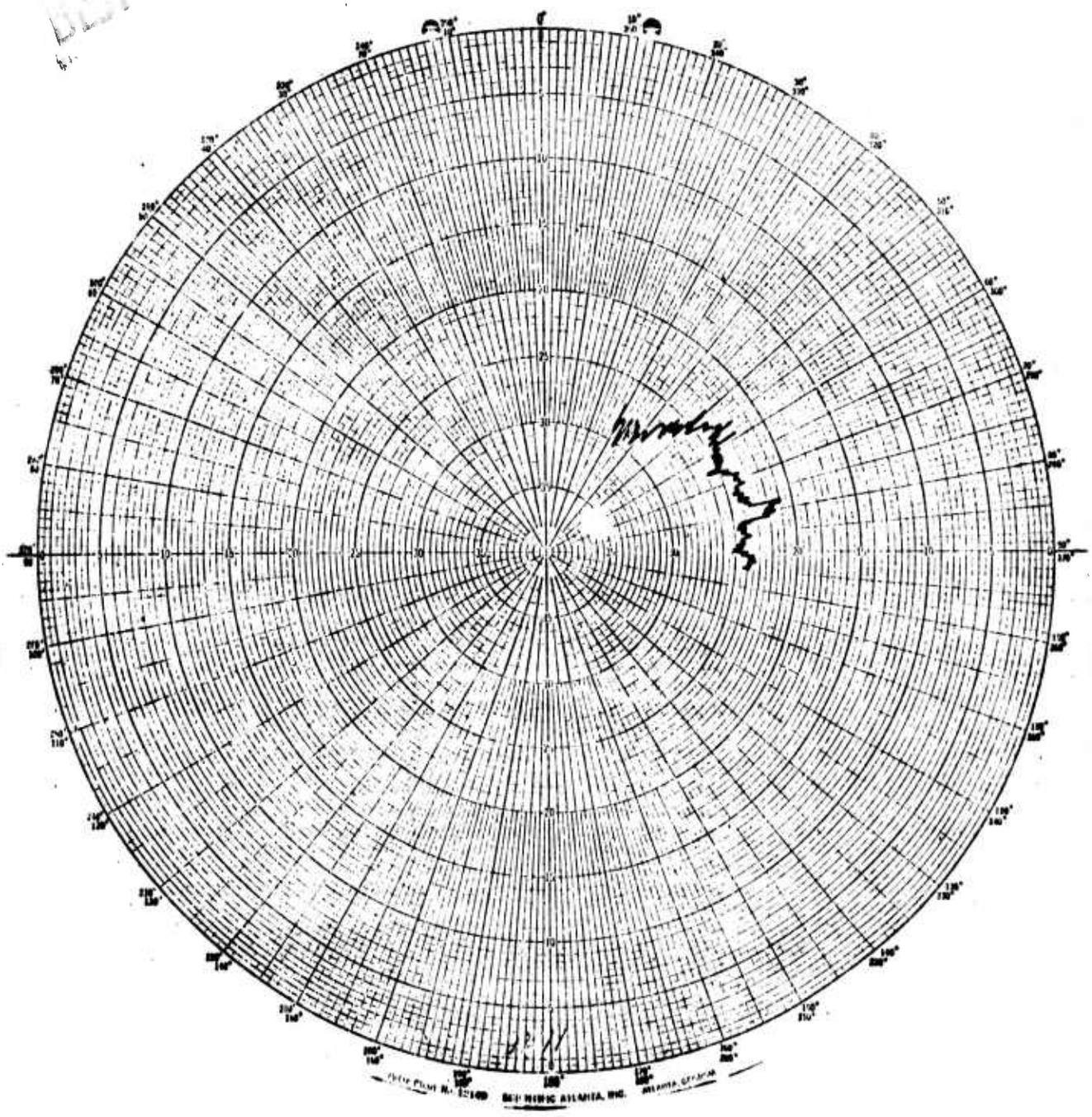


Figure 48. Antenna Pattern No. 11.

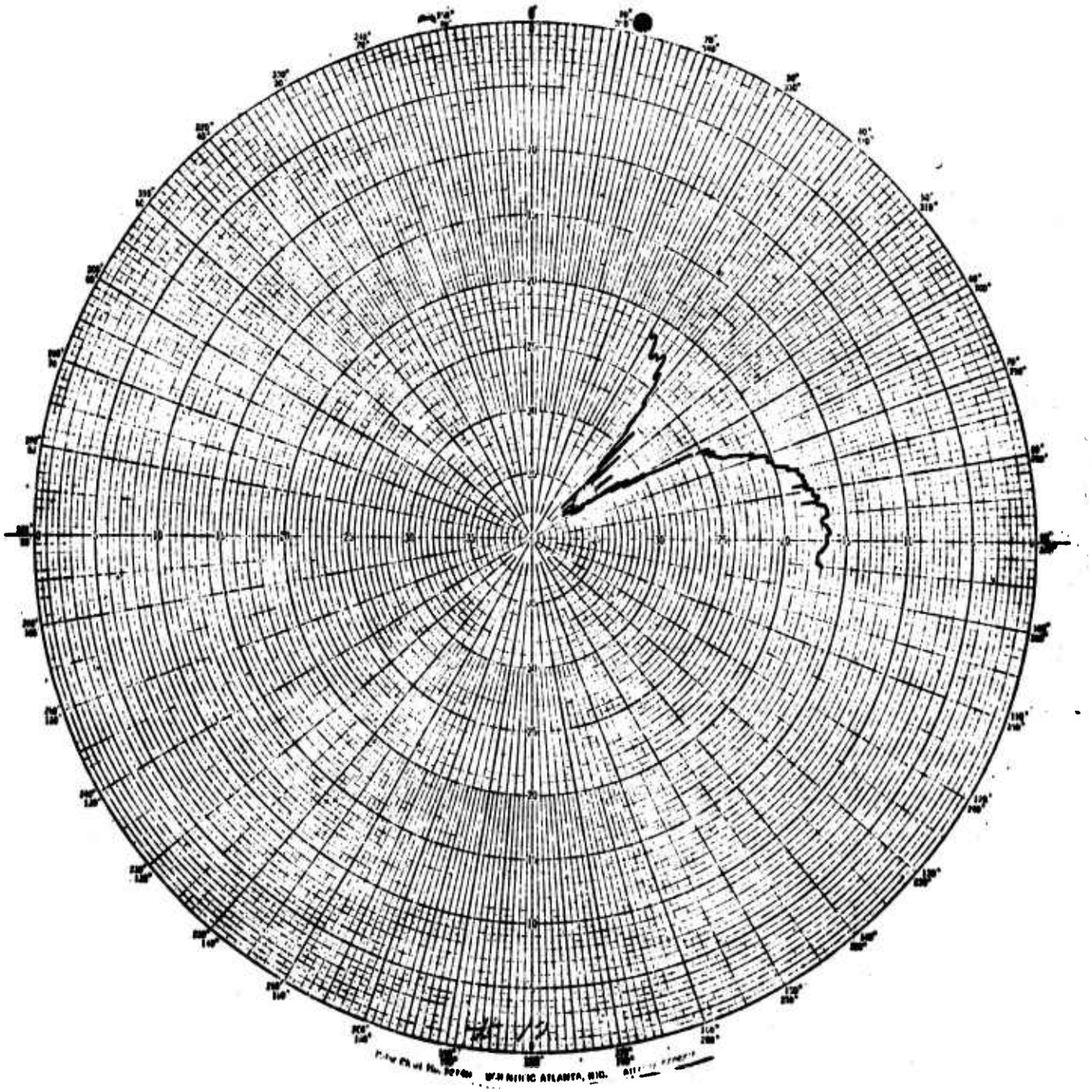


Figure 49. Antenna Pattern No. 12.

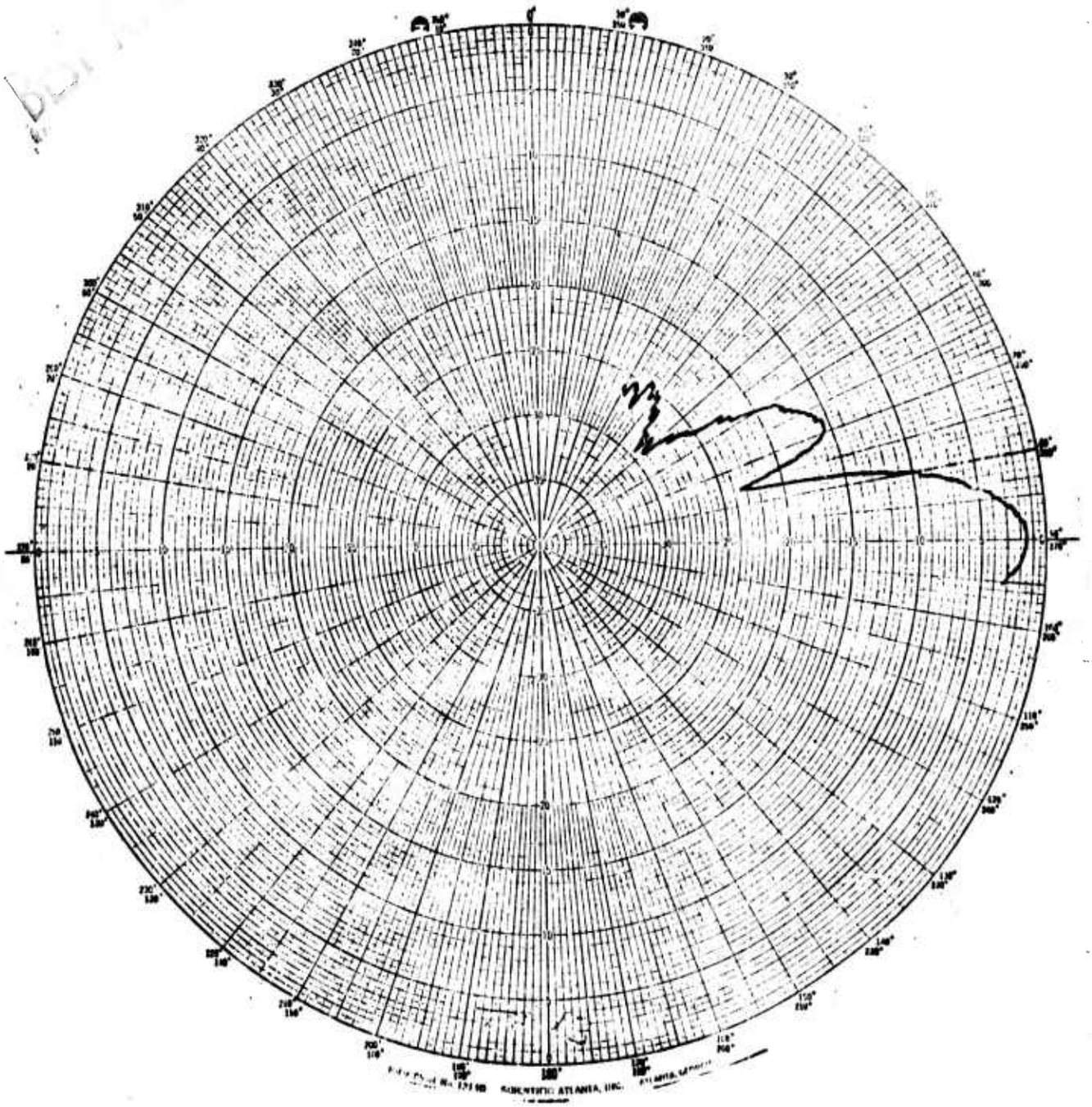


Figure 50. Antenna Pattern No. 13.

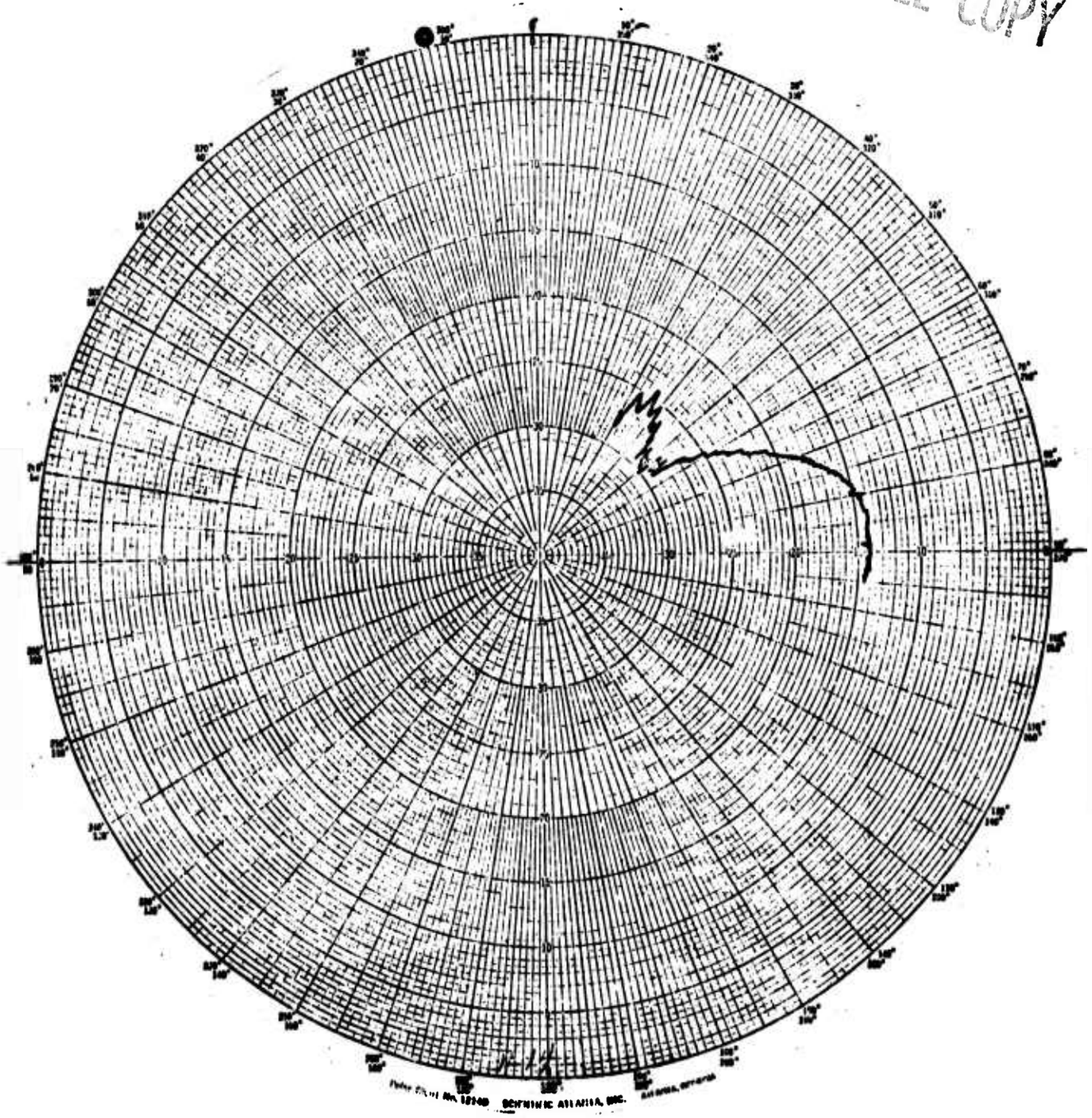


Figure 51. Antenna Pattern No. 14.

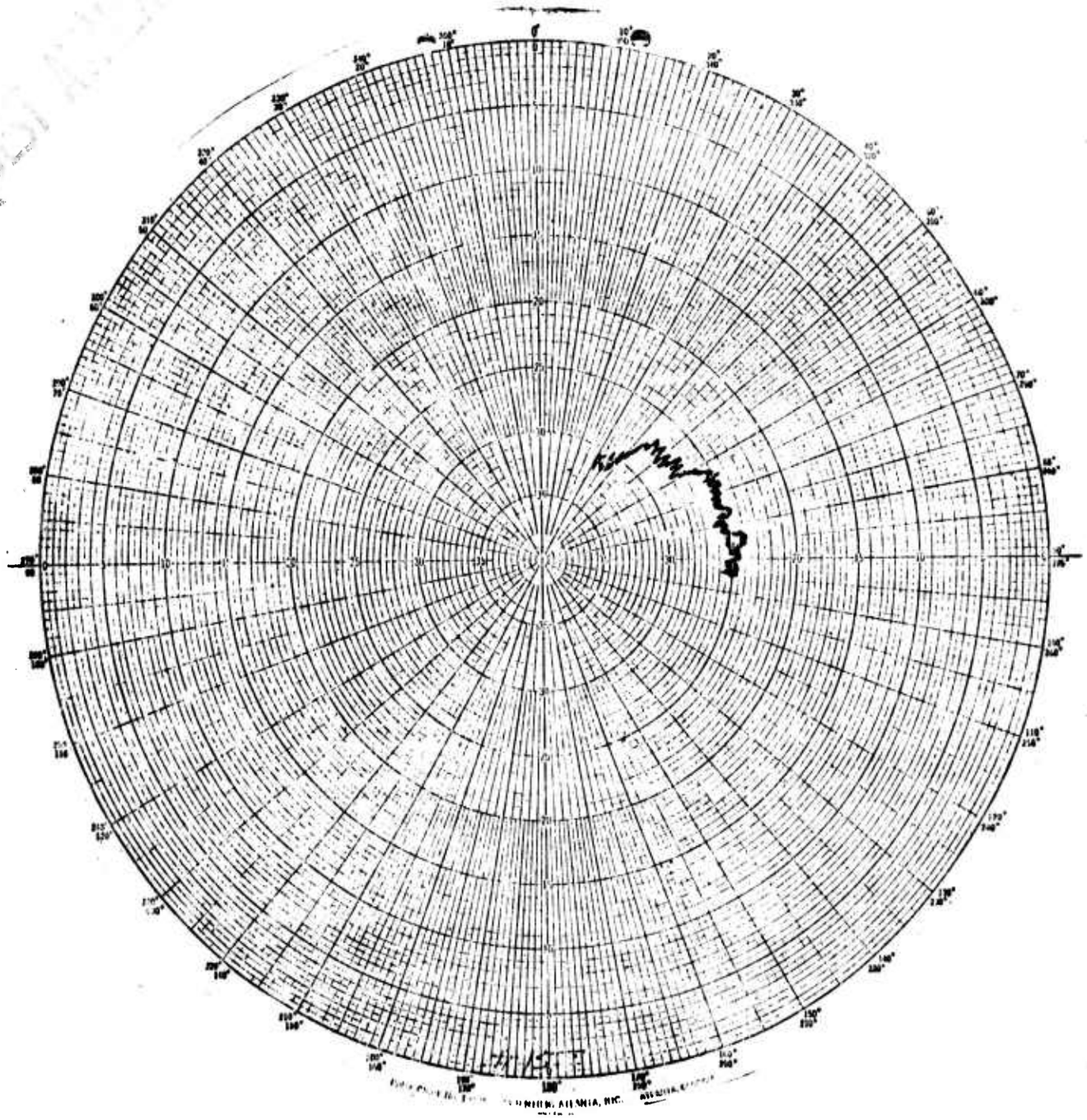


Figure 52. Antenna Pattern No. 15.

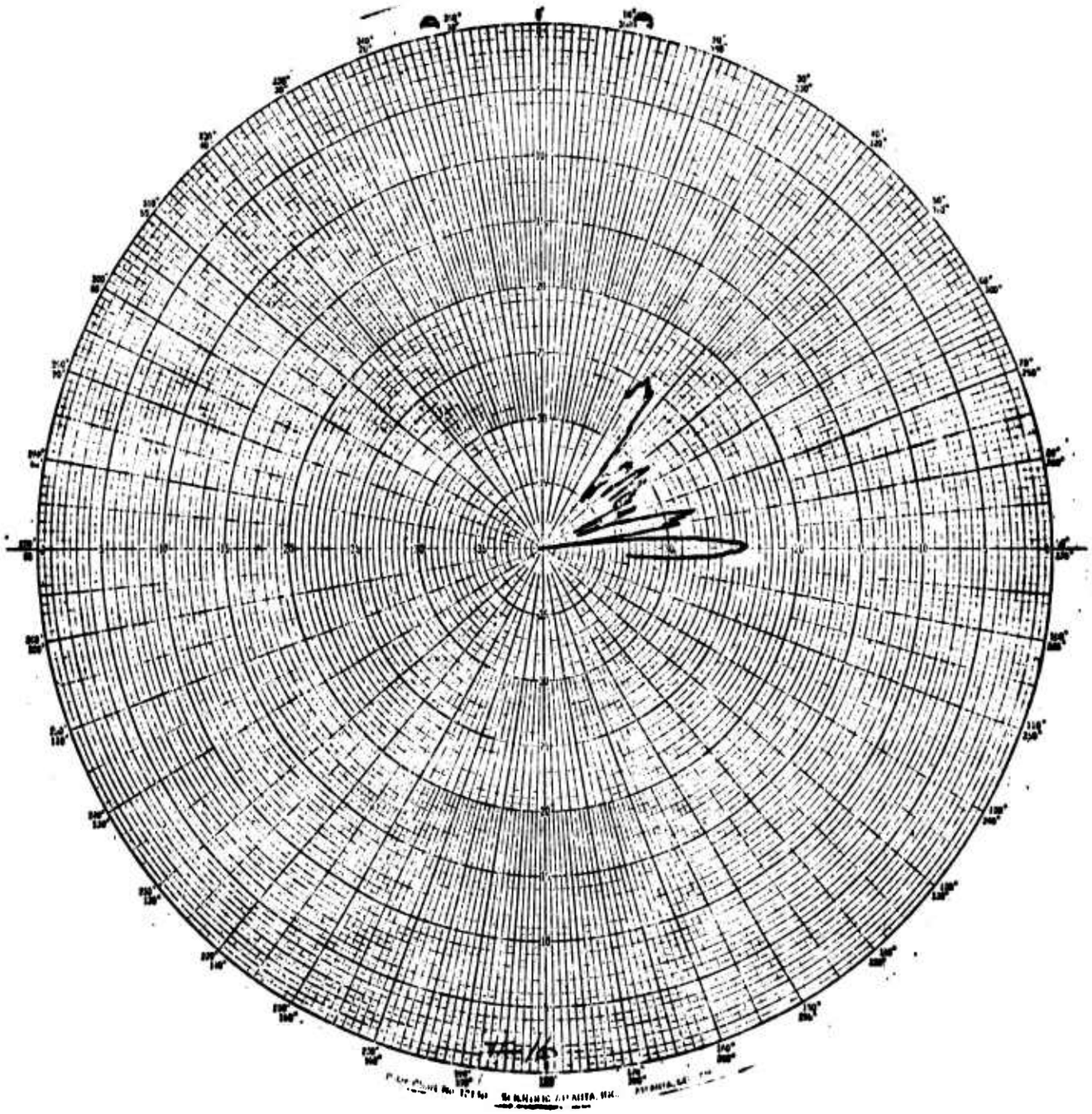


Figure 53. Antenna Pattern No. 16.

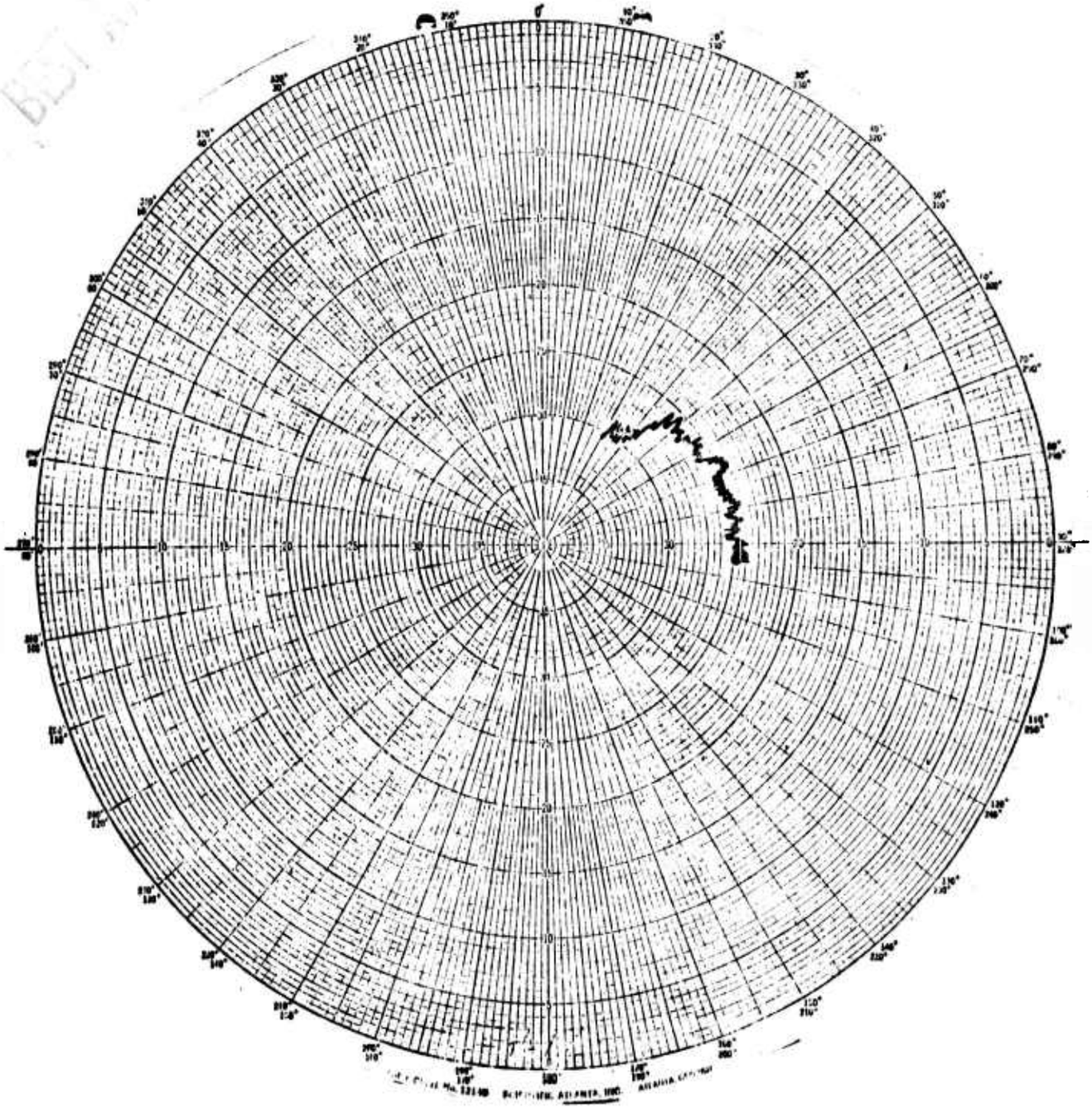


Figure 54. Antenna Pattern No. 17.

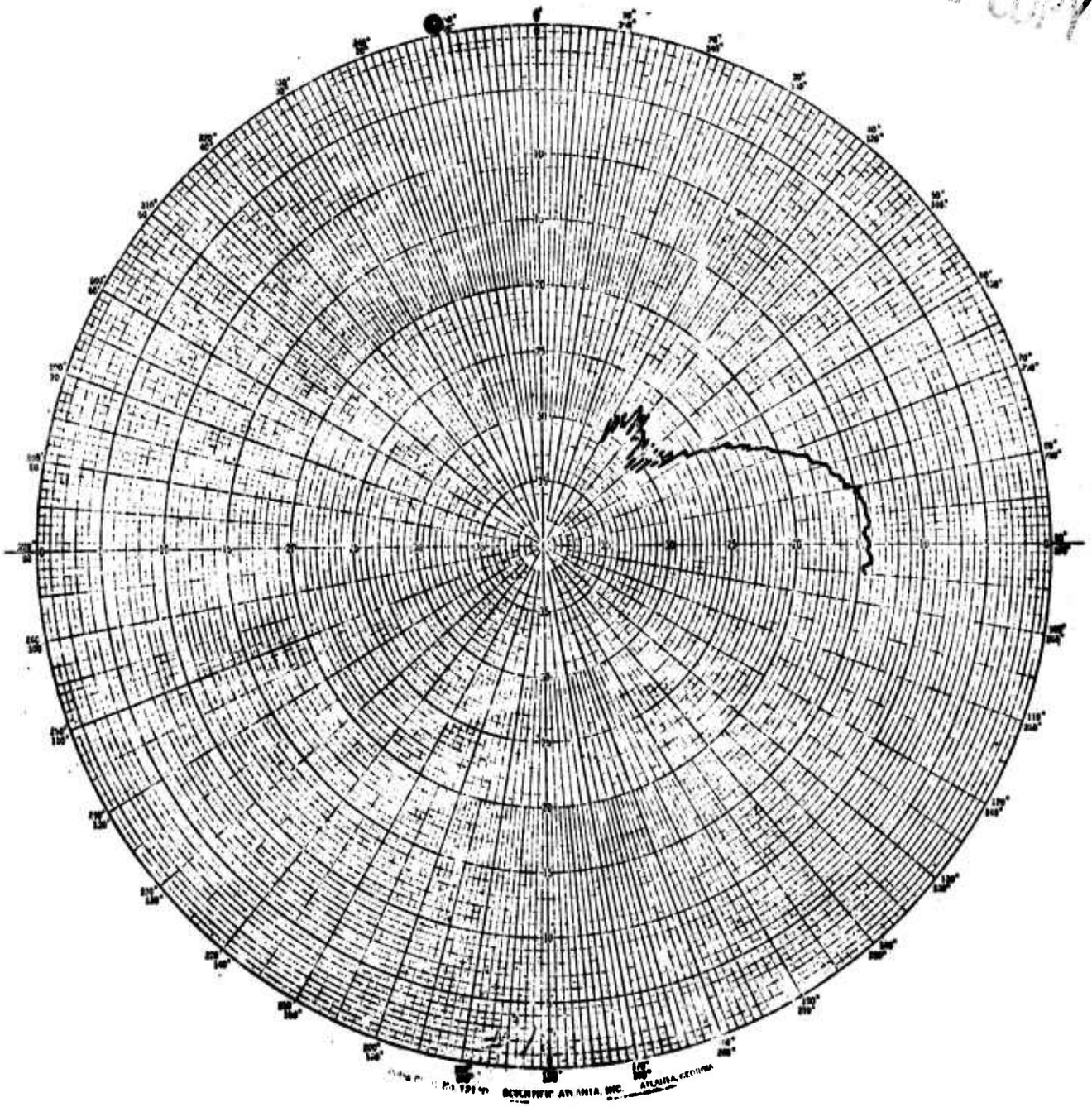


Figure 55. Antenna Pattern No. 18.

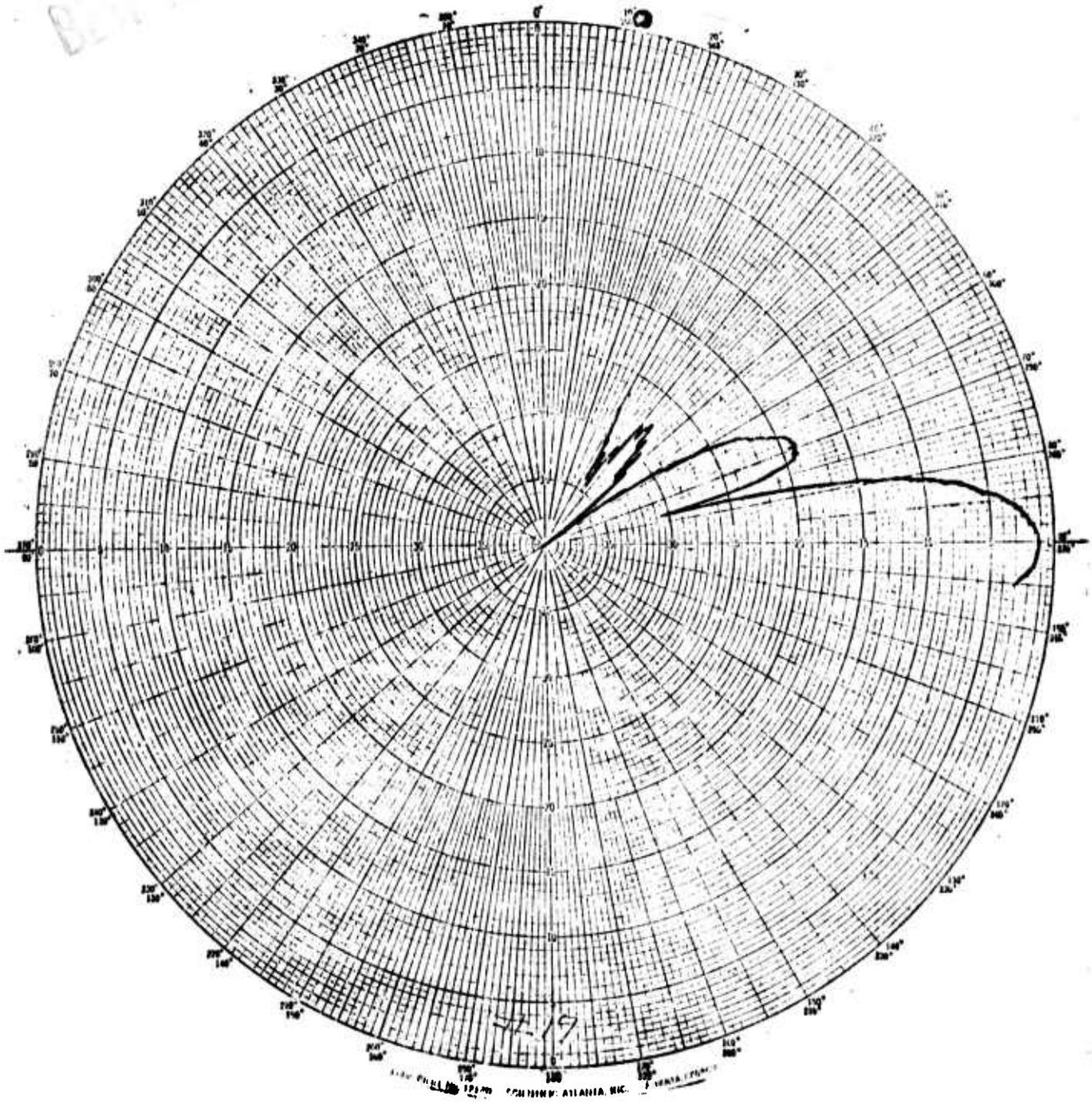


Figure 56. Antenna Pattern No. 19.

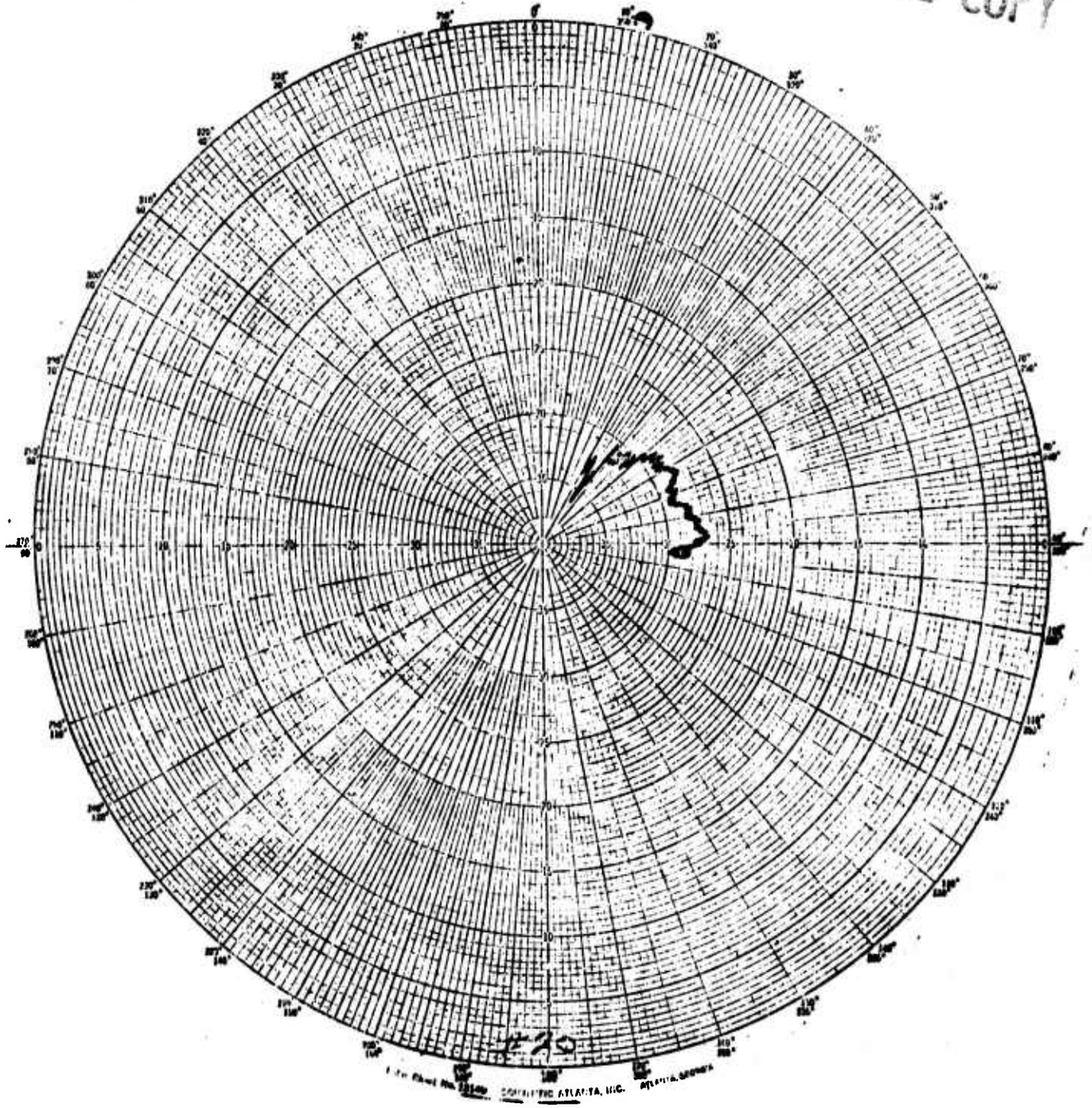


Figure 57. Antenna Pattern No. 20.

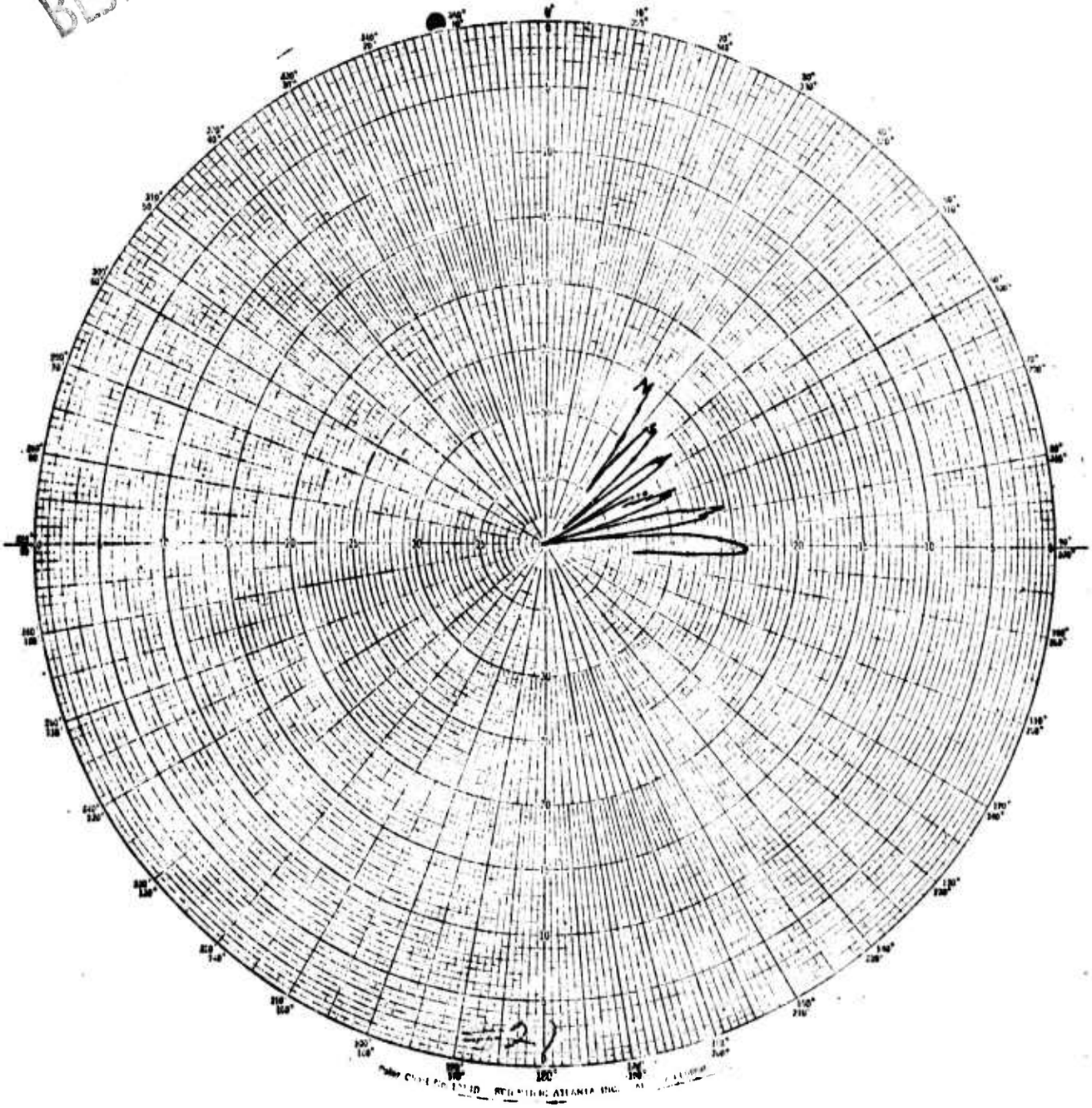


Figure 58. Antenna Pattern No. 21.

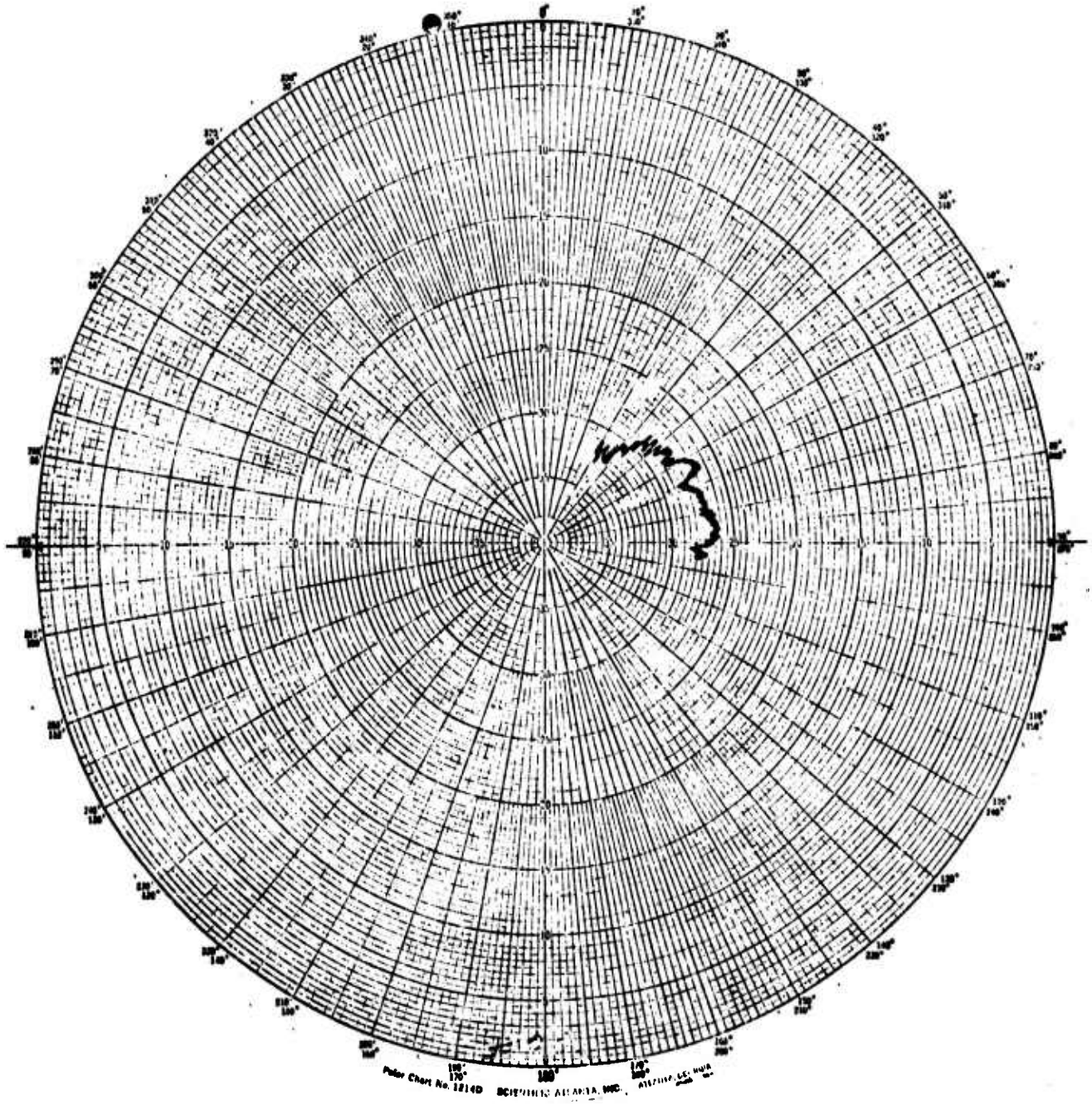


Figure 59. Antenna Pattern No. 22.

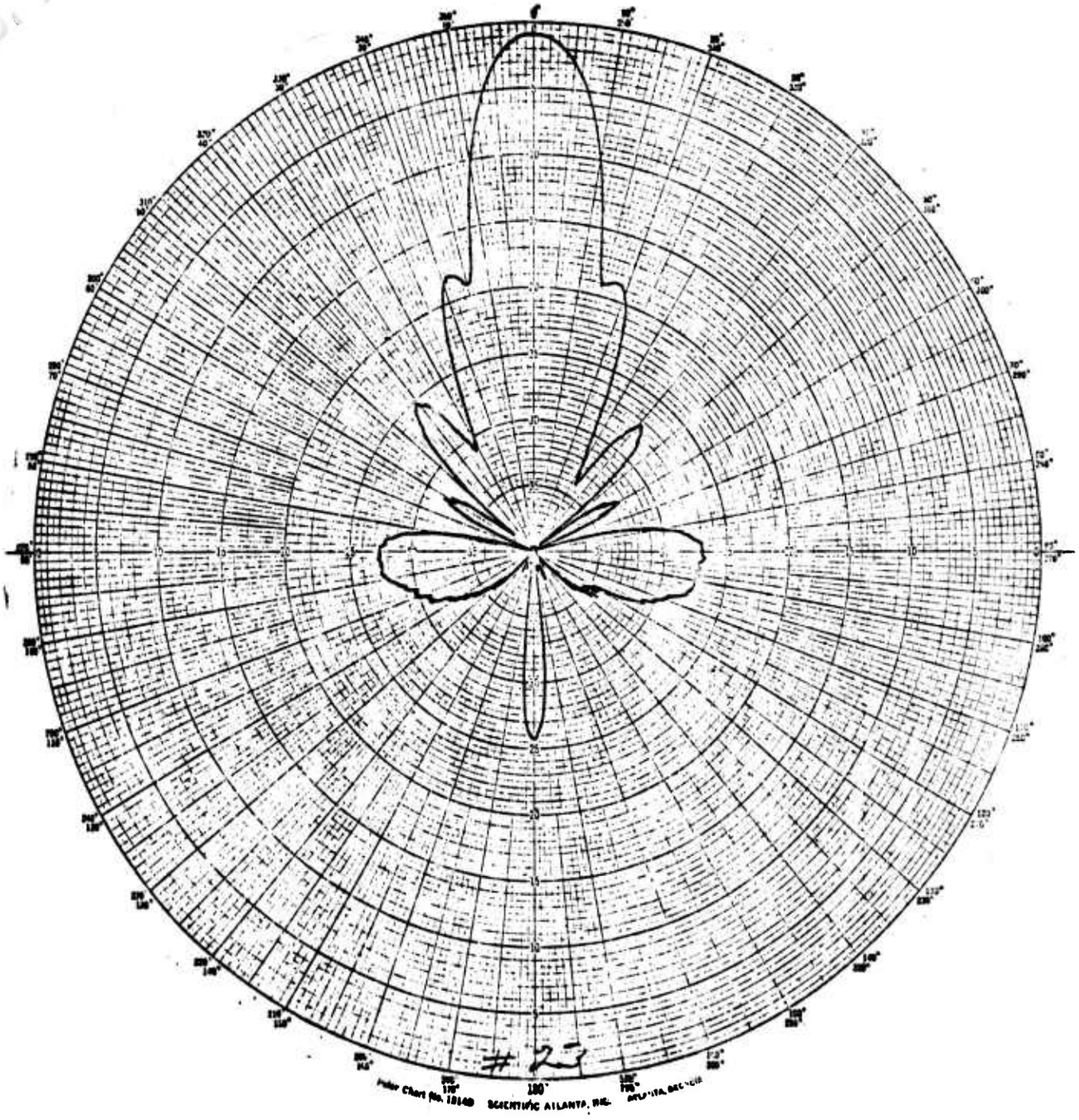


Figure 60. Antenna Pattern No. 23.

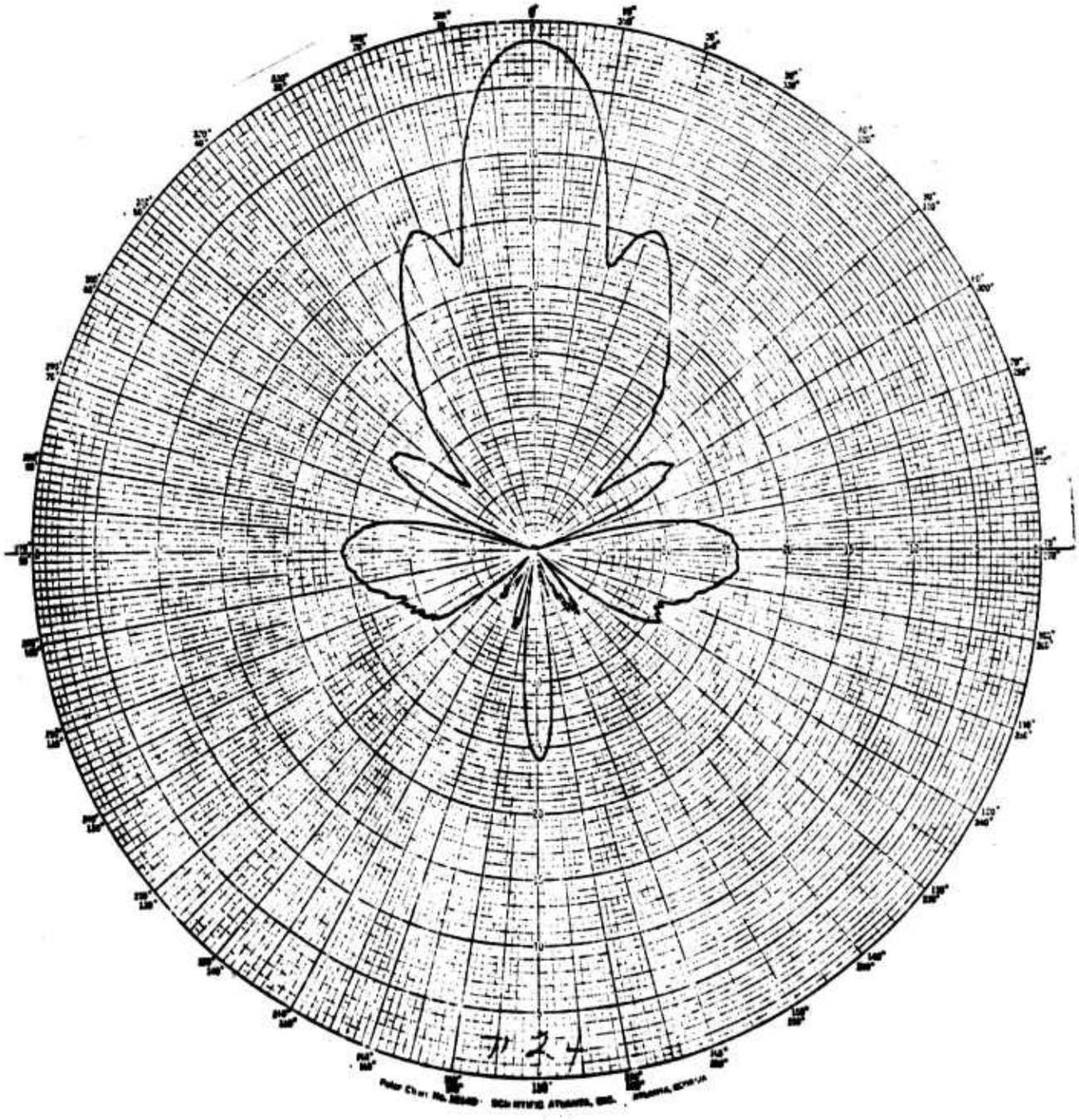


Figure 61. Antenna Pattern No. 24.

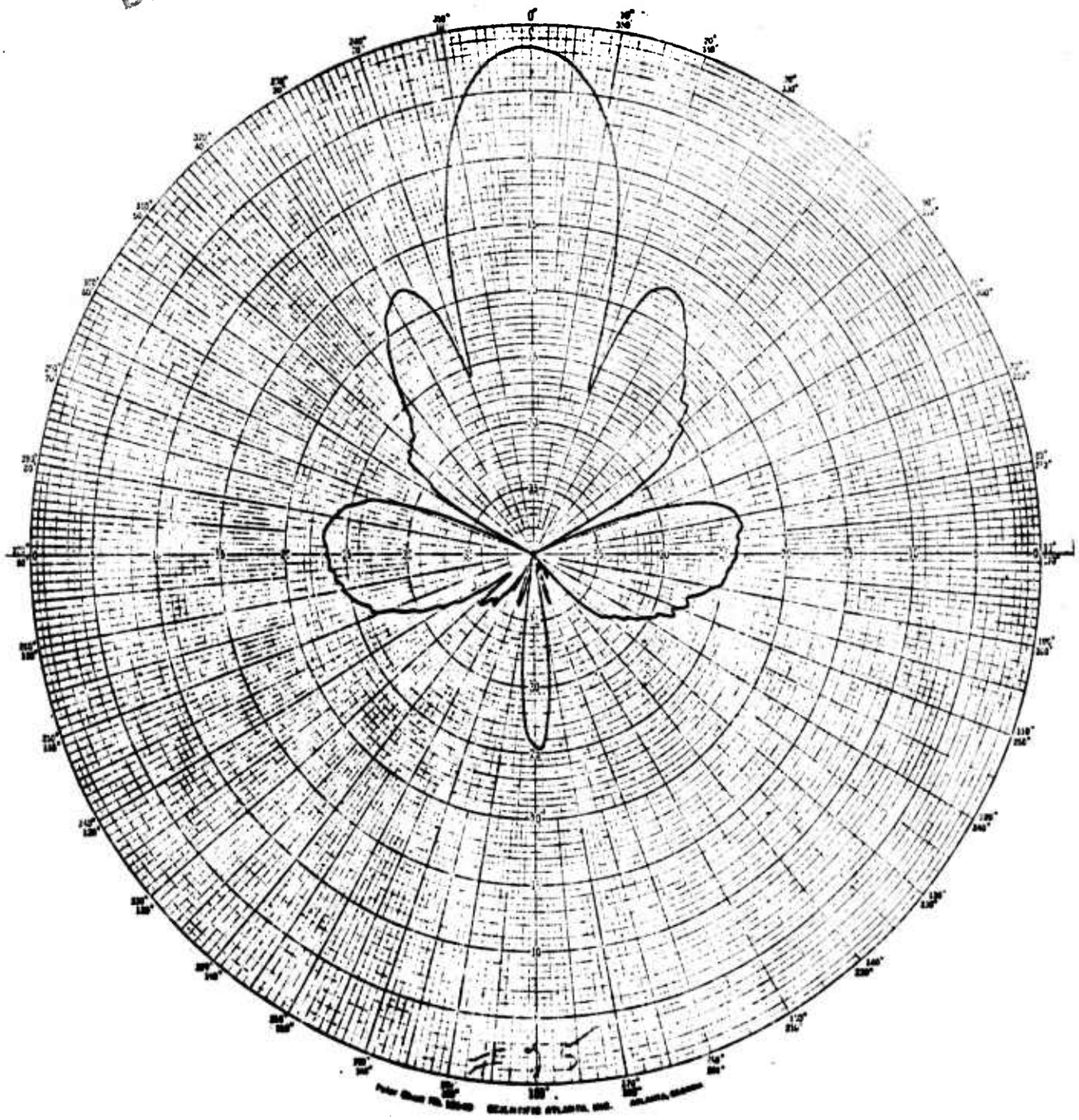


Figure 62. Antenna Pattern No. 25.

APPENDIX C. DEFICIENCIES, SHORTCOMINGS, AND SUGGESTED IMPROVEMENTS

1. DEFICIENCIES

Deficiency	Suggested Corrective Action	Remarks
1.1 The unmodified frequency-multiplier AM-4323/GRC-103(V) did not withstand the effect of high humidity. Para 2.39	None	The 40A2, frequency multiplier ceased to operate.
1.2 The test item failed to withstand the effects of vibration. Para 2.42	None	Upon completion of the vehicular vibration test, the transmitter had no power output or driver output.
1.3 The test item had five failures of 40A2 frequency multipliers and the secondary failure of one additional 40A2 as a result of centrifugal fan failure. An additional secondary failure was the melting of the plastic case of the tube adjustment control covers, which froze the controls. This can be directly attributed to the centrifugal fan failure. Para 2.46	Replace defective frequency multiplier (40A2) with ones having design failures corrected.	The tube adjustment controls and covers are made from plastic which melts at higher than normal operating temperatures, causing an inability to tune the JAN 7211 tubes.
1.4 DTM 11-5820-540-12 and P is confusing and incomplete. Draft Equipment Publication 11-5820-540-35 is incomplete. There is a lack of repair parts data for replacement of assemblies and subassemblies at the organization maintenance category. Paras 2.47.2 and 2.47.3	Update inadequate equipment publications. Add needed repair parts data to present TM's or produce appropriate parts manuals.	There are no instructions for the removal of 40AR1 in the DEPTM. The text of DTM 11-5820-540-12 and P does not follow functional group sequence as listed in the MAC. Replacement parts are not listed in the DEPTM. The replacement procedure for the circulator

Deficiency	Suggested Corrective Action	Remarks
1.4 (Cont)		(391HY1) is incomplete. There are no removal or replacement procedures for the amplifier, frequency multiplier, regulator, and current and regulator voltage subassembly. This prevents the identification and acquisition of replacement parts by personnel in the field. Paras 2.47.2 and 2.47.3.

2. SHORTCOMINGS

Shortcoming	Suggested Corrective Action	Remarks
2.1 There is no voltage warning label in the radio. Para 2.2	Add a warning label by the driver tubes.	There is a 630-volt shock hazard to maintenance personnel by the driver tubes.
2.2 An electron tube interchangability problem exists in that the manuals specify a particular manufacturer of the tube to insure proper performance. Para 2.47.3	None	The TM's specify the use of Machlett JAN 7211 only. Machlett does not make the only JAN 7211 tube in the Army inventory. When the non-Machlett tubes are used, the transmitter does not perform to specifications.

Shortcoming	Suggested Corrective Action	Remarks
2.3 The design of certain features of this test item extends maintenance time. Paras 2.47.3 and 2.47.5	Standardize the part number.	The inconsistency of part numbers for the electron tube is confusing. The inaccessibility of the circulators mounting screw is prejudicial to the ease of maintenance, and the requirement to remove the front panel to facilitate removal of the circulator without removal instructions in the equipment publications extends maintenance time.

APPENDIX D. MAINTENANCE DATA

MAINTENANCE ANALYSIS CHART INSTRUCTION SHEET

DESCRIPTION

COLUMN

1 GROUP AND SEQUENCE NUMBERS. FUNCTIONAL GROUP NUMBER AS INDICATED IN THE MAINTENANCE ALLOCATION CHART (OR TB-750-93-1) OF THE ASSEMBLY OR SUBASSEMBLY. THE SEQUENCE NUMBER OF THE MAINTENANCE ACTION IS IN PARENTHESES BELOW THE GROUP NUMBER.

2 COMPONENT AND RELATED OPERATIONS. COMPONENT AND RELATED MAINTENANCE FUNCTIONS AS INDICATED IN THE MAINTENANCE ALLOCATION CHART. MAINTENANCE FUNCTIONS ASSIGNED TO DEPOT CATEGORY MAINTENANCE ARE NOT NORMALLY SHOWN.

3 SUBSYSTEM ID. A SUBSYSTEM IDENTIFIER ASSIGNED BY THE TEST AGENCY PRIOR TO THE TEST. EXAMPLE: ENGINE ASSIGNED SUBSYSTEM IDENTIFIER "A," TRANSMISSION ASSIGNED SUBSYSTEM IDENTIFIER "B," ETC.

4 MAINTENANCE CATEGORY, PRESCRIBED. THE MAINTENANCE CATEGORY PRESCRIBED BY THE MAINTENANCE ALLOCATION CHART IS INDICATED USING THE FOLLOWING CODE: C - OPERATOR/CREW; O - ORGANIZATIONAL; F - DIRECT SUPPORT; H - GENERAL SUPPORT; D - DEPOT.

MAINTENANCE CATEGORY, RECOMMENDED. USE THE CODE LETTERS, C, O, F, H, OR D TO INDICATE THE MAINTENANCE CATEGORY RECOMMENDED BY THE TEST AGENCY.

MAINTENANCE CATEGORY, ACTUAL. THE ACTUAL MAINTENANCE LEVEL AT WHICH THIS TASK WAS PERFORMED AT THE TEST AGENCY.

5 TM INSTRUCTIONS, ADEQUATE. AN X IN THIS COLUMN INDICATES THE TM INSTRUCTIONS COVERING THIS MAINTENANCE TASK OR ACTION ARE ADEQUATE.

TM INSTRUCTIONS, INADEQUATE. WHEN THE TM INSTRUCTIONS ARE CONSIDERED INADEQUATE, INSERT THE TEST AGENCY EPR NUMBER (IF APPROPRIATE) WHICH TRANSMITTED THE DA FORM 2028.

EPG FORM 1313A (REV)
3 AUG 1974

SUPERSEDES EPG FORM 1313A, DTD 15 JUL 1973 WHICH IS OBSOLETE.

COLUMN

6 ACTIVE MAINTENANCE TIME. MANHOURS AND CLOCK HOURS REQUIRED FOR THE MAINTENANCE OPERATION TO THE NEAREST TENTH OF AN HOUR. ELAPSED HOURS ARE THE TOTAL HOURS THAT THE MAINTENANCE ACTION REQUIRED INCLUDING ALL DELAYS. IF THE OPERATION WAS NOT ACTUALLY PERFORMED BUT WAS REVIEWED, THE ESTIMATED ACTIVE MAINTENANCE TIME IS INDICATED BY USING THE PREFIX E. (UNUSUAL DIFFERENCES IN MAINTENANCE TIMES FOR THE SAME OPERATION SHOULD BE EXPLAINED IN THE BODY OF THE TEST REPORT.)

7 SYSTEM LIFE. THE NUMBER OF OPERATIONAL HOURS (ESSENTIAL) AND MILES, ROUNDS, EVENTS, ETC., AS REQUIRED IN THE TEST PLAN, ACCUMULATED DURING THE TEST BEFORE MALFUNCTION OR SCHEDULED SERVICE OCCURRED. (UNDER THE LIFE FIGURE, ENTER IN PARENTHESES THE SEQUENCE NUMBER FOR WHICH THAT PARTICULAR OPERATION WAS LAST PERFORMED FOLLOWED BY THE APPROPRIATE LIFE UNIT; I.E., M, H, R, ETC.). "S" WILL BE PLACED IN THIS COLUMN IF THE OPERATION WAS PERFORMED ON A SAMPLING BASIS AND NOT BECAUSE OF AN ACTUAL MAINTENANCE ACTION.

8 DIAGNOSTIC TIME. THE PORTION OF MAINTENANCE TIME CLOCK HOURS WHICH WERE USED TO DIAGNOSE THE MALFUNCTION.

9 REASON PERFORMED. THE SYMBOL "UNSCHED" WILL BE ENTERED IN THIS COLUMN IF THIS OPERATION WAS PERFORMED AS A RESULT OF UNSCHEDULED MAINTENANCE. IF THE OPERATION WAS PERFORMED AND RECORDED AS A REQUIRED PORTION OF A SCHEDULED MAINTENANCE SERVICE, THE SYMBOL "SCHED" WILL BE USED. IF THE OPERATION WAS PERFORMED ONLY TO VERIFY PROCEDURES OR TOOL REQUIREMENTS, NOT TO CORRECT A MALFUNCTION, THE SYMBOL "SIM" WILL BE ENTERED.

NOTE. SEPARATE MAINTENANCE ANALYSIS CHARTS WILL BE USED TO RECORD SIMULATED MAINTENANCE ACTIONS.

10 REMARKS. WHEN AN EPR IS RELATED TO A MAINTENANCE OPERATION, THE EPR NUMBER IS ENTERED. THE REMARKS COLUMN WILL BE USED TO IDENTIFY MAINTENANCE FUNCTIONS WHICH ARE CONSIDERED FAILURES FOR RELIABILITY COMPUTATIONS. THE TIME IN MANHOURS PRESCRIBED BY THE MAC TO PERFORM EACH FUNCTION WILL ALSO BE ENTERED HERE OR LOCALLY DEVISED FORMS MAY REQUIRE ENTRY OF THE INFORMATION IN A SEPARATE COLUMN. CSF DENOTES CHARGEABLE SYSTEM FAILURE.

EPG FORM 1313A (REV)
3 AUG 1974

SUPERSEDES EPG FORM 1313A, DTD 15 JUL 1973 WHICH IS OBSOLETE.

MAINTENANCE ANALYSIS CHART PROJECT NO. 6-EE-GRC-103-011 NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS IDENTIFICATION NO. 0001 PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	SUB ITEM	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT PRE REC ACT	TM INSTRUCTIONS ADOT INAOQT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3	4	5		6		7	8	9	10
0000 (1)	INSPECTED FOR COMPLETENESS AND PERFORMED PREOPERATIONAL CHECK TM-11-5820-540-12		0 0 0	X	0.4 NC	0.4	0.4 NC	0.0 -H	0.0	SCHED	
0000 (2)	REMOVED AM- 4323 AND RETURNED TO EACTORY AETER FAILURE DURING SYSTEM TEST.		0 0 0	X	0.0	0.0	0.0	48.00-H	0.0	UNSCHED	VERBAL FAILURE ANALYSIS FROM THE CONTRACTOR INDICATE A 40A2 FREQUENCY MULTIPLIER FAILURE. CSF EPR KH-13

MAINTENANCE ANALYSIS CHART | PROJECT NO. 6-FE-GRC-103-011 | NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS | IDENTIFICATION NO. 0002 | PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	SI BI D	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT PRE	REC	ACT	TM INSTRUCTIONS AUQT	INADQT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
I	2	3	4			5		6			7	8	9	10
0000 (1)	INSPECTED FOR COMPLETENESS AND PERFORMED PRE-OPERATIONAL CHECK TM-11-5820-540-12		0	0	0	X		0.4 NC	0.4 NC	0.4	0.0 -H	0.0	SCHED	
0000 (2)	REMOVED AM-4323 AND RETURNED TO FACTORY AFTER FAILURE DURING SYSTEM TEST.		0	0	0	X		0.0	0.0	0.0	25.00-H	0.0	UNSCHED	VERBAL FAILURE ANALYSIS FROM THE CONTRACTOR INDICATE A 40A2 FREQUENCY MULTIPLIER FAILURE. CSF EPR KH-13

MAINTENANCE ANALYSIS CHART | PROJECT NO. 4-FE-GRC-103-011 | NOMENCLATURE AN/GRC-103 RAND IV COMPONENTS | IDENTIFICATION NO. 0003 | PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL S U P E R V I S O R C-OPERATOR/CREW O-ORGANIZATION F-DIRECT I M-GENERAL D D-DEPOT PRE	REC	ACT	TM INSTRUCTIONS ADDT	INADDT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3	4		5		6			7	8	9	10
0000 (1)	INSPECTED FOR COMPLETENESS AND PERFORMED PREOPERATIONAL CHECK TM 11-5820-540-12	0	0	0	X		0.4 NC	0.4 NC	0.4	0.0 -H	0.0	SCHED	
0000 (2)	REMOVE AN-4323 AND RETURN TO FACTORY AFTER FAILURE DURING SYSTEM TEST.	0	0	0	X		0.0	0.0	0.0	27.00-H	0.0	UNSCHED	VERBAL FAILURE ANALYSIS FROM THE CONTRACTOR INDICATE A 4GAZ FREQUENCY MULTIPLIER FAILURE. CSF FPR KH-13

MAINTENANCE ANALYSIS CHART PROJECT NO. e-FE-GRC-103-011 NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS IDENTIFICATION NO. 0004 PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL (S U B 1 2 3) C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT PRE	REC	ACT	TM INSTRUCTIONS ADDT	INADDT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE M-HOURS E-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3	4		5		6			7	8	9	10
0000 (1)	INSPECTED FOR COMPLETENESS AND PERFORMED PREOPERATIONAL CHECK TM-11-5820-540-12	0	0	0	X		0.4 NC	0.4 NC	0.4 NC	0.0 -H	0.0	SCHED	
0000 (2)	REMOVED AM-4323 AND RETURNED TO FACTORY AFTER FAILURE DURING SYSTEM TEST.	0	0	0	X		0.0	0.0	0.0	36.00-H	0.0	UNSCHED	VERBAL FAILURE ANALYSIS FROM THE CONTRACTOR INDICATE A 40A2 FREQUENCY MULTIPLIER FAILURE. CSF FPR KH-13

MAINTENANCE ANALYSIS CHART | PROJECT NO. F-FE-GRC-103-011 | NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS | IDENTIFICATION NO. 0008 | PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	SOURCE, MAINTENANCE, RECOVERABILITY CODE (S, M, R)	MAINTENANCE LEVEL C-OPERATOR/CREW D-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT			TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME			SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
			PRE	REC	ACT	ADOT	INADOT	CLOCK HOURS	MAN HOURS	ELAPSE HOURS				
1	2	3	4			5		6			7	8	9	10
0000 (1 A)	INSPECTED FOR COMPLETENESS AND PERFORMED PREOPERATIONAL CHECK TM 11-5820-540-12		D	D	D	X		0.4 NC	0.4	0.4 NC	0.0 -H	0.0	SCHED	TEST DISCLOSED NO OUTPUT AND NO INDICATION OF DRIVER IN METER SEE 1303-I NO 502
0040 (1 B)	DIAGNOSED DEFECTIVE RADIO AMPLIFIER 40ARI OF AMPLIFIER-FREQUENCY MULTIPLIER AM 4323.REF TM-11-5820-540-35			D		X		3.0	3.0	3.0	0.0 -H	3.0	UNSCHED	NO DRIVER INDICATION AND NO POWER OUTPUT.NO MAC CHART IN TM-11-5820-540-12.INITIAL INSPECTION.
0002 (1 C)	ALIGNED AMPLIFIER,FREQUENCY MULTIPLIER 40A2.NO INSTRUCTIONS IN TM.DEPOT ALIGNMENT		D	H	D		2028	0.4	0.8	0.4	0.0 -H	0.1	UNSCHED	ALIGNMENT WAS PERFORMED BY MARCONI REP.IT IS FELT THAT REPLACEMENT AND ALIGNMENT COULD BE PERFORMED AT GENERAL SUPPORT.NO MAC TIME.INITIAL INSPECTION.
0002 (1 D)	REPAIRED MULTIPLIER 40A2 DRIVE SHAFT.NO TM DEPOT MAINTENANCE FACTORY REPAIR		D	D	D		2028	0.7	1.4	0.7	0.0 -H	0.2	UNSCHED	WHEN UNIT WAS RECEIVED 40ARI WAS THOUGHT TO BE DEFECTIVE.AFTER VISUAL INSPECTION MULTIPLIER 40A2 DRIVE SHAFT WAS FOUND BROKEN.NO MAC TIME.INITIAL INSPECTION.
0002 (1 E)	ADJUSTED DRIVER AND OUTPUT TUBES FOR MAXIMUM OUTPUT.THIS MUST BE DONE AFTER REPLACEMENT OF 40A2.			F	F		2028	0.5	1.0	0.5	0.0 -H	0.2	UNSCHED	DTM 11-5820-540-12 DOES NOT CONTAIN PROCEDURES FOR TUBE ADJUSTMENT ON THE BAND IV/GRC-103.NO MAC TIME.LOW DRIVER AND POWER OUT

MAINTENANCE ANALYSIS CHART | PROJECT NO. 6-EE-GRC-103-011 | NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS | IDENTIFICATION NO. 0010 | PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL (SYS ID) PRE	REC	ACT	TM INSTRUCTIONS ADOT	INADOT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3	4		5		6			7	8	9	10
0000 (1)	INSPECTED FOR COMPLETENESS AND PERFORMED PREOPERATIONAL CHECK TM 11-5820-540-12	O	O	O	X		0.4 NC	0.4	0.4 NC	0.0 -H	0.0	SCHED	
0002 (2 A)	FOUND THE CENTRIFUGAL FAN B1 OF TRANSMITT CASE CY-4637()/GRC-103 TO BE FOUND DEFECTIVE.THE FAN B1 IS NOT PART OF BAND IV.	F	F	F	X		0.7	0.7	0.7	150.50-H	0.2	UNSCHED	DURING NORMAL OPERATION THE OVERHEAT LAMP LIT AND IT WAS NOTICED THAT THE FAN B1 W AS NOT OPERATIONAL.REPLACEMENT FOR B1 WILL COME FROM MANUFACTUR. EPR KH-6,KH-8
0002 (2 B)	REPLACED DRIVER TUBE V1 IAW DTM 11-5820-540-12	O	O	O	X		0.2	0.4	0.2	150.50-H	0.0	UNSCHED	AFTER REPLACEMENT OF DRIVER TUBE THE TUBE CAVITY MUST BE ADJUSTED.NO INSTRUCTIONS ARE CONTAIN IN TM FOR ADJUSTMENT. MAC TIME FOR TUBE REPLACMENT .3 HRS.LOW DRIVER.
0002 (2 C)	REPLACED OUTPUT TUBE V2 IAW DTM 11-5820-540-12	O	O	O	X		0.2	0.4	0.2	150.50-H	0.0	UNSCHED	AFTER REPLACEMENT OF OUTPUT TUBE V2 TUBE CAVITY MUST BE ADJUSTED.NO INSTRUCTIONS FOR ADJUSTMENT IS CONTAIN IN TM. MAC TIME FOR TUBE REPLACEMENT .3 HRS.LOW OUTPUT EPR KH-6,KH-8
0002 (2 D)	PLASTIC SANDWICH ABOUT TUBE CAVITY ON 40AR1 MELTED DUE TO EXCESSIVE HEAT.REPLACED 40AR1.		H	H		2028	0.7	0.7	0.7	150.50-H	0.2	UNSCHED	DURING TROUBLESHOOTING OF THE 40AR1 IAW DEP TM 11-5820-540-35 IT WAS NOTED THAT THE TUBE CAVITY COULD NOT BE ADJUSTED.TM DOES NOT CONTAIN INSTRUCTIONS FOR ADJUST EPR KH-6,KH-8
0002 (2 E)	ADJUSTED DRIVER AND OUTPUT TUBES V1 AND V2.	NP	F	F		2028	0.5	1.0	0.5	150.50-H	0.0	UNSCHED	STILL HAVE LOW POWER OUTPUT NO INSTRUCTIONS IN TM FOR ADJUSTMENT OF TUBES.NO MAC TIME.LOW DRIVER AND POWER OUT EPR KH-6,KH-8

MAINTENANCE ANALYSIS CHART | PROJECT NO. 6-FE-GRC-103-011 | NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS | IDENTIFICATION NO. 0010 | PAGE 7

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL (SUB I D) C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT PRE REC ACT	TM INSTRUCTIONS ADOT INADOT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3 4	5		6		7	8	9	10
0202 (2 F)	REPLACED AMPLIFIER,FREQUENCY MULTIPLIER 40A2.NO INSTRUCTIONS IN DEP 11-5820-540-35	H H H	2028	0.2	0.4	0.2	150.50-H	0.1	UNSCHED	AFTER REPLACEMENT OF 40A2 UNIT OUTPUT POWER RETURNED TO NORMAL. MAC TIME 0.2. EPR KH-6,KH-8
0002 (2 G)	ADJUSTED DRIVER V1 AND OUTPUT V2 TUBES FOR MAXIMUM OUTPUT. THIS MUST BE DONE AFTER REPLACING FREQUENCY MULTIPLIER	NP F F	2028	0.5	1.0	0.5	150.50-H	0.2	UNSCHED	EPR KH-6,KH-8

MAINTENANCE ANALYSIS CHART | PROJECT NO. 6-FE-GRC-103-011 | NOMENCLATURE AN/GRC-103 BAND IV COMPONENTS | IDENTIFICATION NO. 0012 | PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	SYS ID	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT PRE	REC	ACT	TM INSTRUCTIONS AUOT	INADOT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-ROUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3	4			5		6			7	8	9	10
0000 (1)	INSPECTED FOR COMPLETENESS AND PERFORMED PREOPERATIONAL CHECK TM 11-5820-540-12		O	O	O	X		0.4 NC	0.4 NC	0.4	0.0 -H	0.0	SCHED	
0002 (2 A)	THE AM4323 AMPLIFIER FREQUENCY MULTIPLIER WAS FOUND TO HAVE A LOW POWER OUT		H	H	H	X		0.2	0.4	0.2	126.20-H	0.0	UNSCHED	CSF EPR KH-7,KH-8
0002 (2 B)	ADJUSTED DRIVER AND OUTPUT TUBES FOR MAXIMUM OUTPUT. THIS MUST BE DONE AFTER FREQUENCY MULTIPLIER IS REPLACED.			F	F		2028	0.5	1.0	0.5	126.20-H	0.2	UNSCHED	DTM 11-5820-540-12EP DOES NOT CONTAIN PROCEDURES FOR TURE ADJUSTMENT ON THE BAND IV/GRC-103.NO MAC TIME. EPR KH-7,KH-8
0002 (3 A)	FOUND THE CENTRIFUGAL FAN B1 OF TRANSMITTER CASE CY-4637()/GRC-103 TO BE DEFECTIVE AND WAS REPLACED IAW TM11-5820-540-35		F	F	F	X		0.7	0.7	0.7	1004.00-H	0.2	UNSCHED	DURING RELIABILITY TEST THE UNIT FAILED TO OPERATE. IT WAS FOUND THAT THE BLOWER MOTOR WAS DEFECTIVE.NO MAC TIME. THE CENTRIFUGAL FAN IS NOT PART OF BAND IV. EPR KH-9
0000 (3 B)	CONTRACTOR REPAIRED DAMAGE TO TEST ITEM AS A RESULT OF OVERHEATING CAUSED BY BLOWER FAILURE.		O	O				0.0	0.0	0.0	1004.00-H	0.0	UNSCHED	TIMES TO REPAIR UNKNOWN EPR KH-9

MAINTENANCE ANALYSIS CHART | PROJECT NO. 7-FF-GRC-103-011 | NOMENCLATURE SIMULATED MAINTENANCE FOR BAND IV SN 0000 | IDENTIFICATION NO. 0000-SIMULATED | PAGE 1

GP. NO. (SEQ. NO)	COMPONENT AND RELATED OPERATIONS	SUB I D	MAINTENANCE LEVEL PRE	REC	ACT	TM INSTRUCTIONS AUOT	INAUOT	ACTIVE MAINTENANCE TIME CLOCK HOURS	MAN HOURS	ELAPSE HOURS	SYSTEM LIFE H-HOURS M-MILES R-POUNDS	DIAG TIME	REASON PERFORMED	REMARKS
1	2	3	4			5		6			7	8	9	10
0203 (1 A)	REMOVED AND REPLACED VOLTAGE REGULATOR 40 A3 TM 11-5820-540-12		0	0	0	X		0.2E NC	0.2E NC	0.2	0.0 -H	0.0	SIM	
0204 (1 B)	REMOVED AND REPLACED CONTROL INDICATOR 40 A4 TM-11-5820-540-12		0	0	0	X		0.2E NC	0.2E NC	0.2	0.0 -H	0.0	SIM	
0104 (1 C)	REMOVED AND REPLACED CONTROL INDICATOR 39 A4 TM-11-5820-540-12 6P		0	0	0	X		0.2E NC	0.2E NC	0.2	0.0 -H	0.0	SIM	
0106 (1 D)	REMOVED AND REPLACED AMPLIFIER RF 39AR1 TM-11-5820-540-12 6P		0	0	0	X		0.2E NC	0.2E NC	0.2	0.0 -H	0.0	SIM	

Instructions for Maintenance Package Literature Chart

COLUMN

1 Number. Enter Army or manufacturer's publication or draft manual number.

2 Quantity. Number of copies received. Insert "0" if none were supplied. Use Chapter 9, AR 310-3, as a guide to determine those publications that should accompany the test item. Publications contained in the maintenance test package should cover operations and functions through general support maintenance and should specify the categories involved.

3 Title. Complete title.

4 Date Received, Literature. Enter date publication was received.

5 Date Received, Materiel. Enter date test item or materiel was received.

6 & 7 Evaluation. Insert "X" in appropriate block. Minor errors noted on DA Form 2028 are not in themselves sufficient reasons to term a publication inadequate.

8 Form 2028. Insert EPR number (if appropriate) and date DA Form 2028 was forwarded.

9 Remarks. In addition to appropriate remarks, explain if manuscript was not evaluated and the reason therefor.

MAINTENANCE PACKAGE LITERATURE CHART	PROJECT NO 6-EE-GRC-103-011	NOMENCLATURE Radio Set AN/GRC-103 Band IV

MANUSCRIPT			DATE RECEIVED		EVALUATION		FORM 2028	REMARKS
NUMBER	QTY	TITLE	LIT	MATERIEL	ADQT	INADQT	DATE FORWARDED	
1	2	3	4	5	6	7	8	9
DTM 11-5820-540-12 & P	3	Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tool List, Radio Sets AN/GRC-103 1, 2, 3, and 4, not dated	17Dec75	17Dec75		X		
DEP 11-5820-540-35	3	Direct Support, General Support, and Depot Maintenance Manual, Radio Sets AN/GRC-103(V) 1, 2, 3, and 4, 1 June 75	17Dec75	17Dec75		X		

STEEP-MT-E Form 11
1 Aug 75

Instructions for

Tools and Test, Measurement, and Diagnostic Equipment (TMDE) Chart

COLUMN

1 Nomenclature or Description. Enter the nomenclature as shown in the manual or if none, enter noun nomenclature and brief description of item. (Enter in parentheses the number of like items received, such "(2 ea)".)

2 Federal Stock Number or Part Number. Enter one of the following: Federal Stock Number, Part Number, or Drawing Number in this order.

3 Maintenance Category, Prescribed. Maintenance category authorized the item as prescribed by the technical publication.

4 Maintenance Category, Recommended. Indicate the maintenance category to be authorized the item as recommended by test agency. If the item is not required, enter none.

5 Date Received. Enter the date the tool or item of TMDE was received (Example 6/69). Enter "not rec" if the tool or test equipment was not received.

6 Evaluation, Adequate. Enter an X if the item was found to be adequate for use by the mechanics and for its intended purpose at the maintenance category recommended in Column 4. Make no comment on items marked "None" in Column 4.

7 Evaluation, Inadequate. Enter an X if the tool was found to be inadequate for its intended use. Make no comment on tools marked "None" in Column 4.

8 Required (RQD) Yes or No. A "Yes" in this column indicates the special tool or test equipment is required at the maintenance level indicated in Column 4. A "No" in this column indicates the special tool or test equipment is not required. This column should be marked "No" when "None" is marked in Column 4.

9 Listed in Technical Manual. Enter the number of the technical publication for the test item in which the tool or test equipment is listed.

10 Remarks. If an EPR is related to the item, the EPR number will be entered. If the item was used only to verify the need for the item, this will be indicated. When it has been determined that an item is not required, indicate the standard item which will perform the required maintenance function if appropriate.

STEEP-MT-E Form 7a

1 Aug 75

TOOLS AND TMDE CHART	PROJECT NO 6-EE-GRC-103-011			NOMENCLATURE Radio Set AN/GRC-103 Band IV					
NOMENCLATURE OR DESCRIPTION	FSN OR PART NO	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORG F-DIRECT H-GENERAL D-DEPOT		DATE RECEIVED	EVALUATION		RQR YES OR NO	TECHNICAL MANUAL IN WHICH LISTED	REMARKS
		PRESB	RECM		ADQT	INADQT			
1	2	3	4	5	6	7	8	9	10
Attenuator, Fixed 6 dB	5985-00-454-6925	H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Attenuator, Fixed 10 dB	5985-00-865-0108	F,H,D	F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Attenuator, Fixed 10 dB Weinschel Model 20-10		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Attenuator, Fixed 20 dB	5985-00-454-6924	F,D	F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Attenuator, Variable 6-120 dB, 1-2 GHz	4935-00-016-0016	H	H	NR				11-5820-540-12 & P	Not evaluated.
Converter, Frequency, Electronic CV-2500/GR	6625-00-179-5217	O	O	Jan 76	X		YES	11-5820-540-12 & P	
Detector, RF Alfred Model 1001		H,D	H,D	NR				11-5820-540-12 & P	Not evaluated.
Dummy Load, Electrical DA-437/GRC-103(V)	5985-00-089-8990	O,F,D	O,F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Dummy Load, Electrical OS 20020P		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	

STEEP-MT-E Form 7
1 Aug 75

Replaces STEEP-MT-E Form 7 dated 1 May 74

TOOLS AND TMDE CHART	PROJECT NO 6-EE-GRC-103-011			NOMENCLATURE Radio Set AN/GRC-103 Band IV					
NOMENCLATURE OR DESCRIPTION	FSN OR PART NO	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORG F-DIRECT H-GENERAL D-DEPOT		DATE RECEIVED	EVALUATION		RQR YES OR NO	TECHNICAL MANUAL IN WHICH LISTED	REMARKS
		PRESB	RECM		ADQT	INADQT			
1	2	3	4	5	6	7	8	9	IC
Frequency Unit Plug-In 1-2 GHz, Wiltron Model 6110		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Generator, Signal AN/USM-44B	6625-00-857-4352	F,D	F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Generator, Signal AN/USM-213	6625-00-891-9201	F,H,D	F,H,D	Jan 76	X		YES	11-5820-540 12 & P	
Generator, Sweep Frequency SG-888/U (1-1000 MHz) Texscan 200-315		H,D	H,D					11-5820-540-12 & P	Not received.
Generator, Sweep Frequency Wiltron Model 610B		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Indicator SWR AN/UPM-108	6625-00-682-4494	H,D	H,D					11-5820-540-12 & P	Not received.
Multimeter AN/URM-105	6625-00-581-2036	O	O					11-5820-540-12 & P	Not received.
Multimeter TS-352B/U	6625-00-242-5023	F,H,D	O,F,H,D	Jan 76	X		YES	11-5820-540-12 & P	

STEEP-MT-E Form 7
1 Aug 75

Replaces STEEP-MT-E Form 7 dated 1 May 74

TOOLS AND TMDE CHART	PROJECT NO 6-EE-GRC-103-011			NOMENCLATURE Radio Set AN/GRC-103 Band IV					
NOMENCLATURE OR DESCRIPTION	FSN OR PART NO	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORG F-DIRECT H-GENERAL D-DEPOT		DATE RECEIVED	EVALUATION		ROR YES OR NO	TECHNICAL MANUAL IN WHICH LISTED	REMARKS
		PRESB	RECM		ADQT	INADQT			
1	2	3	4	5	6	7	8	9	10
Oscilloscope OS-189A (P) AN/USM-281, HP-180F Option 21		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Power Meter ME-441/U	4031-00-436-4883	F,D	F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Thermistor, Mount MX-2144A/U	4935-00-978-0611	F,D	F,H,D					11-5820-540-12 & P	Not received.
Time Base Plug-In PL-1187A USM HP-1821F Option 21		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Tool Kit Electronic Equipment TK-100/G	5180-00-605-0079	F,H,D	F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Tool Kit Electronic Equipment TK-101/G	5180-00 064-5178	O	O	Jan 76	X		YES	11-5820-540-12 & P	
Tool Kit Electronic Equipment TK-105/G	5180-00-610-8177	F,H,D	F,H,D	Jan 76	X		YES	11-5820-540-12 & P	
Tube Puller, CMC 456-762		O,F,H,D	O,F,H,D	Jan 76	X		YES	11-5820-540-	

STEEP-MT-E Form 7
1 Aug 75

Replaces STEEP-MT-E Form 7 dated 1 May 74

TOOLS AND TMDE CHART	PROJECT NO 6-EE-GRC-103-011			NOMENCLATURE Radio Set AN/GRC-103 Band IV					
NOMENCLATURE OR DESCRIPTION	FSN OR PART NO	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORG F-DIRECT H-GENERAL D-DEPOT		DATE RECEIVED	EVALUATION		ROR YES OR NO	TECHNICAL MANUAL IN WHICH LISTED	REMARKS
		PRES6	RECM		ADQT	INADQT			
1	2	3	4	5	6	7	8	9	10
Vertical, Dual Trace, Differential Plug-In, HP-1806A		H,D	H,D	Jan 76	X		YES	11-5820-540-12 & P	
Voltmeter, Electronic AN/USM-224	6625-00-727-4706	F,D	F,H,D					11-5820-540-12 & P	Not received.
VSWR Auto Tester, Wiltron Model 63N		H,D	H,D					11-5820-540-12 & P	Not received.
Wattmeter, Thruline, Bird Electronics		F,D	F,H,D					11-5820-540-12 & P	Not received.
Wrench, Torque, OSM T 8438		F,H,D	F,H,D	Jun 76		X	YES	11-5820-540-12 & P	Wrench is too large for removal of some connectors.
Cable Assembly, RF CG-409H/U (1.5 feet)	5995-00-235-5048	H,D	H,D	Jun 76	X		YES	11-5820-540-12 & P	
Cable Assembly, RF CG-409H/G (3 feet)	5995-00-760-6143	H,D	H,D	Jun 76	X		YES	11-5820-540-12 & P	
Cable Assembly, RF CG-3568/U (3 feet)		H,D	H,D	Jun 76	X		YES	11-5820-540-12 & P	

STEEP-MT-E Form 7
1 Aug 75

Replaces STEEP-MT-E Form 7 dated 1 May 74

TOOLS AND TIDE CHART	PROJECT NO 6-EE-GRC-103-011			NOMENCLATURE Radio Set AN/GRC-103 Band IV					
NOMENCLATURE OR DESCRIPTION	FSN OR PART NO	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORG F-DIRECT H-GENERAL D-DEPOT		DATE RECEIVED	EVALUATION		ROR YES OR NO	TECHNICAL MANUAL IN WHICH LISTED	REMARKS
		PRESB	RECM		ADQT	INADQT			
1	2	3	4	5	6	7	8	9	10
Cable Assembly, RF CG-3570/U (6 inches)	5820-00-935-5076	F	F	Jun 76	X		YES	11-5820-540-12 & P	
Cable Assembly, RF CG-3573/U (4.8 inches)		F	F	Jun 76	X		YES	11-5820-540-12 & P	
Cable Assembly, Special Purpose		F,D	F,H,D	Jun 76	X		YES	11-5820-540-12 & P	
Cable Kit, Field Maintenance MK-1184/GRC		F	F	Jun 76	X		YES	11-5820-540-12 & P	
Adapter-Connector N (female) to N (female) UG 29B/U		H,D	H,D	Jun 76	X		YES	11-5820-540-12 & P	
Adapter-Connector BNC (female) to N (male) UG 201A/U		H,D	H,D	Jun 76	X		YES	11-5820-540-12 & P	
Adapter-Connector C (female) to N (male) UG 564A/U		H	H	Jun 76	X		YES	11-5820-540-12 & P	
Adapter-Connector N (female) to SMA (female) OS 21010		F,H,D	F,H,D	Jun 76	X		YES	11-5820-540-12 & P	
Adapter-Connector N (female) to SMA (male) OS 21030		H,D	H,D	Jun 76	X		YES	11-5820-540-12 & P	

STEEP-MT-E Form 7
1 Aug 75

Replaces STEEP-MT-E Form 7 dated 1 May 74

PARTS ANALYSIS CHART INSTRUCTION SHEET

GENERAL. THE PARTS ANALYSIS CHART PROVIDES FOR A LISTING OF THE PARTS USED IN MAINTAINING THE TEST ITEM. PARTS WILL BE GROUPED ON THIS CHART BY FUNCTIONAL GROUP AND IN FEDERAL STOCK NUMBER (FSN) NUMERICAL ORDER WITHIN EACH GROUP.

COLUMN	DESCRIPTION
1	GROUP AND SEQUENCE NUMBER. PARTS USAGE BY MAINTENANCE OPERATION IS INDICATED BY A CROSS REFERENCE TO THE GROUP NUMBER AND SEQUENCE NUMBER FROM COLUMN 1 OF THE MAINTENANCE ANALYSIS CHART.
2	FEDERAL STOCK NUMBER. RECORD THE FEDERAL STOCK NUMBER, TECHNICAL SERVICE PART NUMBER, MANUFACTURERS PART NUMBER, OR DRAWING NUMBER IN THIS ORDER OR PREFERENCE.
3	NOUN NOMENCLATURE. AS LISTED IN THE PARTS MANUAL.
4	MAINTENANCE LEVEL, PRESCRIBED. THE MAINTENANCE LEVEL PRESCRIBED BY THE PARTS LIST UNDER REVIEW. USE THE CODE C – OPERATOR/CREW, O – ORGANIZATIONAL, F – DIRECT SUPPORT, H – GENERAL SUPPORT.
5	MAINTENANCE LEVEL, RECOMMENDED. THE CODE SYMBOLS C, O, F, OR H INDICATE THE MAINTENANCE LEVEL RECOMMENDED BY THE TEST AGENCY.
6	PART LIFE. THE NUMBER OF OPERATING HOURS (ESSENTIAL) AND MILES, ROUNDS, EVENTS, ETC., AS REQUIRED BY THE TEST PLAN, ACCUMULATED BY THIS PART. THIS IS ACTUAL PART LIFE AND SHOULD AGREE WITH THE PART LIFE REPORTED ON THE EPR. EACH ENTRY IN THIS COLUMN IS FOLLOWED BY THE APPROPRIATE LIFE UNIT SYMBOL (H, M, OR R).
7	REASON USED. THE SYMBOL UNSCHED WILL BE ENTERED IN THIS COLUMN IF THIS PART WAS USED AS A RESULT OF UNSCHEDULED MAINTENANCE. IF THE PART WAS REPLACED AS A REQUIRED ACTION OF SCHEDULED MAINTENANCE, THE SYMBOL SCHED WILL BE ENTERED. IF THE PART WAS USED AS A TIME CHANGE COMPONENT , TCC WILL BE ENTERED. IF THE PART WAS CONSUMED TO VERIFY PROCEDURES OR TOOLS, NOT TO CORRECT A MALFUNCTION, THE SYMBOL SIM WILL BE ENTERED.
8	REMARKS. IF AN EPR IS RELATED TO THE PART USED, THE EPR NUMBER WILL BE INSERTED IN THIS COLUMN. WHEN THE PART WAS REPLACED TO CORRECT A FAILURE, IT WILL BE INDICATED BY INSERTING THE WORD FAILURE IN THIS COLUMN.

EPG Form 1316 A (Rev) 15 Jul 1973

Supersedes EEP Form 1316 A, 1 Oct 70, which is obsolete

PARTS ANALYSIS CHART

PROJECT NO.
6-FF-GRC-103-011

NOMENCLATURE
AN/GRC-103 BAND IV COMPONENTS

IDENTIFICATION NO.
0010

PAGE
1

GP NO (SEO NO)	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORGANIZATIONAL F-DIRECT H-GENERAL D-DEPOT PRESR	MAINTENANCE LEVEL RECM	PART LIFE H-HOURS M-MILES R-ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
0002 (2 B)(1EA)	SM-A-794144	DRIVER TUBE V1	O	O	150.50-H	UNSCHED	REPLACED FROM SPARE PARTS
0002 (2 C)(1EA)	SM-A-794144	OUTPUT TUBE V2	O	O	150.50-H	UNSCHED	REPLACED FROM SPARE PARTS EPR KH-6,KH-8
0202 (2 F)(1EA)	5820-879-3005	AMPLIFIER,FREQUENCY MULTIPLIER 40A2	H	H	150.50-H	UNSCHED	SPARE PARTS EPR KH-6,KH-8

PARTS ANALYSIS CHART

PROJECT NO.
6-FE-GRC-103-011

NOMENCLATURE
AN/GRC-103 BAND IV COMPONENTS

IDENTIFICATION NO.
0012

PAGE
1

GP NO (SEQ NO)	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL PRESB	MAINTENANCE LEVEL REC'D	PART LIFE	REASON USED	REMARKS
		C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL D-DEPOT			H-HOURS M-MILES R-ROUNDS		
1	2	3	4	5	6	7	8
0002 (3 A)(1EA)	4140879?279	CENTRIFUGAL FAN B1	F	F	1004.00-H	UNSCHED	REPLACED BY ITEM FROM FACTORY EPR KH-9
0202 (2 A)(1EA)	5820-879-3005	AMPLIFIER,FREQUENCY MULTIPLIER 4082	H	H	126.20-H	UNSCHED	SPARE PARTS CSF EPR KH-7,KH-8

APPENDIX E. SOLDIER-OPERATOR/MAINTAINER/TESTER COMMENTS

The soldier-operator/maintainer/tester (SOMTE) comments for maintenance were as follows:

1. During the test, on several occasions, the Band IV AM-4323/GRC-103 was returned to the factoy for repair. Some of the time lost could have been averted if the manual was complete and repair parts made available.

2. The manuals seem to lack the QA/QC for completeness. These manuals should be accurate and complete upon acceptance of equipment prior to DT II in order to avoid costly delays in making necessary changes.

APPENDIX F. REFERENCES

1. Letter, AMSTE-EL, USATECOM, 28 June 1968, subject: Engineering Test, Final Report and Service Test, Interim Letter Report, of Key Generator, Electronic TSEC/KG-27 Used with Low Capacity Assemblages AN/TRC-145, AN/TCC-65, and AN/TRC-113, USATECOM Project No. 6-8-4023-02.

2. Report of USATECOM Project No. 6-EE-GRC-103-003, Engineering Test of Zero Band Heads for Radio Set, AN/GRC-103, USAEPG Publication No. FR-379, March 1970.

3. Letter, AMSTE-EL, USATECOM, 26 June 1970, subject: Final Report, Engineering and Service Test of Zero Band Heads for Radio Set, AN/GRC-103, USATECOM Project No. 6-EE-GRC-103-001/003.

4. Specification, EL-CPO150-0001A, Radio Set AN/GRC-103(V)IV, 11 December 1972, with Amendment No. 1, 6 December 1973.

5. Military Standard, MIL-STD-454C, Standard General Requirements for Electronic Equipment, 15 October 1970.

6. Military Standard, MIL-STD-1472A, Human Engineering Design Criteria for Military Systems Equipment and Facilities, 15 May 1970.

7. Military Standard, MIL-STD-252B, Wired Equipment, Classification of Visual and Mechanical Defects.

8. Military Standard, MIL-STD-882, System Safety Program for Systems and Associated Subsystems and Equipment; Requirements for, 15 July 1969.

9. Military Standard, MIL-STD-461A, Electromagnetic Interference Characteristics Requirements for Equipment, Change 4, 9 February 1971.

10. Military Standard, MIL-STD-462, Electromagnetic Interference Characteristics, Measurements of, 1 August 1968.

11. Military Standard, MIL-STD-810B, Environmental Test Methods, with changes.

12. Letter, AACOMS Project Manager, AMCPM-AA-PA-7, 18 April 1972, subject: Request to Stop Reliability Test -- IPT of AN/GRC-103, Band I, Magnavox Production.

13. TECOM Letter, AMSTE-EL, 10 February 1971, subject: Test Directive, Initial Production Test of Radio Set AN/GRC-103(V), Band I, Band II, and Band III Components, ..., USATECOM Project No. 6-EE-GRC-008.

14. TECOM Message, AMSTE-EL, 14 February 1972, subject: Supplemental Test Directive, IPT of Radio Set AN/GRC-103(V), Band I, TECOM Project 6-EE-GRC-103-008.

15. Test Plan, Initial Production Test of Radio Set AN/GRC-103(V) with Band I Components, August 1971, Publication No. USAEPG-TP-682.

16. Test Report, Band I, AN/GRC-103(V), First Article Approval, 19 November 1970.

17. Independent Government Test Execution Plan (IGTEP) for Radio Set AN/GRC-103(V)2 and Radio Set AN/GRC-103(V)3, August 1971.

18. Engineering Design Test Plan for Evaluation of AN/GRC-103(V) IV radio Equipment, 22 January 1975.

APPENDIX G. ABBREVIATIONS

AACOMS	Army Area Communications System
AGC	automatic gain control
ANT	antenna
CHAN	channel
dB	decibel
dBm	decibels (referred to 1 milliwatt in 600 ohms)
DUPL	duplexer
EMI	electromagnetic interference
EPR	Equipment Performance Report
ET & ST	engineering and service test
FDM	frequency division modulation
FREQ	frequency
FSD	full scale deflection
FWD	forward
^{o}F	degrees Fahrenheit
MAV	minimum acceptable value
Hz	hertz
IF	intermediate frequency
IGTEP	Independent Government Test Execution Plan
IPT	initial production test
kHz	kilohertz
MTP	materiel test procedures
MHz	megahertz
NGT	not greater than
NLT	not less than
NMT	not more than
nsec	nanosecond
LOS	line of sight
OW	order wire
PCM	pulse code modulation
P-P	peak-to-peak
PWR	power
RCVR	receiver
REFL	reflected
REQ	requirement
RF	radio frequency
rms	root mean square
SN	serial number
SPEC	specification
TMG	timing

S/N	signal-to-noise ratio
VAC	volts alternating current
VCO	voltage control oscillator
Vdc	volts direct current
VSWR	voltage standing wave ratio
VTVM	vacuum tube voltmeter
XMTR	transmitter

APPENDIX H. DISTRIBUTION LIST

*No. of draft copies to be sent to TECOM for approval prior to final distribution.

	Test Plan	Final Report
Commander, TECOM		
ATTN: DRSTE-EL	9	12*
ATTN: DRSTE-EL	2	1
ATTN: DRSTE-SG-H		1
ATTN: DRSTE-PT-MT	1	
Aberdeen Proving Ground, MD 21005		
Commander, DARCOM		
ATTN: DRCQA	1	1
ATTN: DRCSF	1	1
ATTN: DRCSA-ND	1	1
5001 Eisenhower Ave.		
Alexandria, VA 22333		
Commander		
USA Electronics Command		
ATTN: DRSEL-RD-TT	5	5
Ft. Monmouth, NJ 07703		
Project Mansger		
Army Tactical Communications Systems		
ATTN: DRCPM-ATC	5	5
Fort Monmouth, New Jersey 07703		
Commander, OTEA		
ATTN: DACS-T-EO	3	3
5600 Columbis Pike		
Falls Church, VA 22041		
Commander, TRADOC		
ATTN: TRADOC LnO	5	5
HQ, TECOM		
Aberdeen Proving Ground, MD 21005		
Commander, TRADOC		
ATTN: ATCD-PM	1	1
ATCD-TM	1	1
Ft. Monroe, VA 23651		
Commander, CACDA		
ATTN: ATCA-CCM	1	1
Ft. Leavenworth, KA 66027		

	Test Plan	Final Report
Commander USA Logistics Center ATTN: ATCL-M Ft. Lee, VA 23801	2	2
Commander, USLEA ATTN: DALO-LEI New Cumberland Army Depot New Cumberland, PA 17070		
HQDA (DAMA-PPM-T) Washington, DC 20310	2	2
HQDA (DALO-SMM-E) Washington, DC 20310		1
HQDA (DALO) Washington, DC 20310	1	1
HQDA (DAMO-FD) Washington, DC 20310	1	1
HQDA (DAPC-PMO) Alexandria, VA 22331	2	2
HQDA (DAEN) Washington, DC 20314	1	1
Commander, DDC ATTN: Document Service Center Cameron Station Alexandria, VA 22314		2
Commander USA Maintenance Management Center ATTN: DRXMD-E ATTN: DRXMD-T Lexington, KY 40507	2 1	2 1
USMC LnO HQ, TECOM Aberdeen Proving Ground, MD 21005	1	1
Director Joint Tactical Communications Office ATTN: TRI-TAC/TT-RT TRI-TAC/TT-O Ft. Monmouth, NJ 07703	1 1	1 1

	Test Plan	Final Report
Director, Development Center Marine Corps Development and Education Command Quantico, VA 22134	1	1
Commandant of the Marine Corps ATTN: Code RD HQ, Marine Corps Washington, DC 20380	1	1
Commander, TRADOC Combined Arms Test Activity ATTN: ATCAP-OP Ft. Hood, TX 76544	1	1
Director, AMSAA ATTN: DRXSY-R Aberdeen Proving Ground, MD 21005	1	1
Commander, USAEHA ATTN: HSE-OB Aberdeen Proving Ground, MD 21010		1
Director, DRCFSA ATTN: DRXOS-ES Charlestown, IN 47111		1